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臺灣就讀幼兒園對早期幼兒發展之影響

To Give Children an Edge? The Effects of Preschool Attendance on Early Childhood Development in Taiwan

林博謙

Po-Chien Lin

指導教授：蘇國賢 博士

Advisor: Kuo-Hsien Su, Ph.D.

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The Effects of Preschool Attendance on Early Childhood Development in Taiwan

本論文係林博謙君（R09325008）在國立臺灣大學社會學系、所完成之碩士學位論文，於民國 111 年 7 月 22 日承下列考試委員審查通過及口試及格，特此證明

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謝辭

對我來說，完成碩士論文雖非鑽研這個題目的終點，卻也是一個重大里程碑。寫作過程中，我最深刻的心得是任何稍有品質的學術研究都建立在無數資源挹注、善意與扶持之上才得以成事。我首先必須感謝的是指導教授蘇國賢。若沒有蘇老師，我可能無法想像學術生涯的進程，也不會認為社會學研究是值得追尋的目標。在總是啟發人心的學術討論與全心全意的學術支持外，蘇老師也在適當時候砥礪我的人格，或以身作則成為那個凝聚與團結眾人的存在，讓我在待人處事上學到不少。我還要感謝農業經濟系的楊豐安老師，在三年的助理生涯中，老師如親切學長般的傾囊相授讓我從完全不認識又什麼都不會的大學生變成可以勉強稱自己是您的共同研究者的研究生。老師給我統計方法實作上的密切指導讓我可以把課堂上學到的抽象估計式化為正確運行的 code，也讓我得以找到可能範圍內最適當的方法設計套用在我的論文上。我還要感謝郭貞蘭老師，對這篇研究從粗糙的草稿、期末報告、到考大綱的半成品一路給予許多寶貴的建議。我非常慶幸能找到三位專長各異又都相當慎重看待我的論文的校外口試委員：中研院歐美所黃敏雄老師、政大姜以琳老師、以及師大張鑑如老師。我想感謝這三位老師極具啟發性且專業的評論讓我的論文在構框、測量與寫作各方面獲得長足的進展。其中黃老師和張老師口試後還撥冗與我討論論文細項修改事宜，更是感激不盡。

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摘要

幼兒的早期發展在理論與實證上已被證明對個人的長期發展有深遠的影響，而早期教育是決定早期發展成敗之關鍵。然而，多數支持早期教育的證據皆來自歐美小規模、高強度、且針對經濟與社會上弱勢孩童之社會實驗。大規模的早期教育制度，特別是在東亞社會中的早期教育，則較缺乏實證研究支持其有效性。本文使用臺灣幼兒發展調查資料庫(Kids in Taiwan, KIT)的全國代表性長期追蹤資料，搭配雙重差分法(difference-in-differences)與傾向分數配對法(propensity score matching)估計就讀幼兒園對六項早期發展指標的效果。結果顯示就讀幼兒園平均而言顯著增加孩童的語言發展、社會能力、和身體動作發展達三到七個百分點，並顯著減少孩童侵略性達百分之十二。分群分析顯示效果僅能在來自中等收入家庭、男性、或與祖父母同住的孩童身上發現。本文呈現出就讀幼兒園平均而言對孩童有益。家庭收入與幼兒園效果間的非線性關係顯示就讀幼兒園在台灣既不會助長、也不會減少幼童的經濟不平等。

關鍵字：幼兒園、早期發展、因果關係

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Abstract

Early childhood development has been theoretically modeled and empirically shown to be crucial to one's later-life outcomes, and early education is known to play an important role during this period. However, much of the empirical evidence supporting early education is based on small-scale randomized intervention programs that target disadvantaged children in the U.S. and European countries. Less is known about the effectiveness of early education in the East Asian context. In particular, Taiwan is a unique case due to its rising supply of cheap, highly accessible preschools in an ultra-low fertility society, which needs answer to whether they prepare children well given their affordability. Using the nationally representative, longitudinal Kids in Taiwan (KIT) dataset, this paper presents the causal relationships between preschool attendance and child's early developmental outcomes in Taiwan. Difference-in-differences matching estimates present that preschools on average improve children's language development, social competence, and motor development by 3 to 7 percent, and reduces aggressiveness by 12 percent. By conducting subgroup analyses, the effects are only found on children that are from families of medium income, male, or coresiding with grandparents. While preschools in Taiwan are moderately beneficial to their attendants in various aspects, the non-linear relationship between household income and preschool effects indicates that preschools neither increase nor decrease economic inequality.

Keywords: Preschool Effects, Early Childhood Development, Causal Inference

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1. Introduction

In the last decades, the world has witnessed a rapid expansion in supply of early childhood education and care (ECEC, or ECE for early childhood education). The average 3-5 years old preschool enrollment rate of OECD (2022) countries has been constantly rising, some of them such as Poland and Lithuania have experienced a more than 40 percent increase in 3-year-old preschool enrollment rate in the last twenty years. According to National Institute for Early Education Research (Friedman-Krauss et al., 2022), from 2002 to 2021, U.S. enrollment rate of 4-year-old children has risen from 14 percent to 29 percent. In Taiwan, the 2-5 years old enrollment rate of preschool increases from 57.7 percent in 2014 to 67.3 percent in 2019 (Ministry of Education in Taiwan, 2020a: p.5). In the United States and Europe, the debate of universal preschool programs versus targeted programs[1] is at the center of the discussion of early education. Of the 44 U.S. states that provide some kind of state preschool program, seven[2] of them offer universal or mostly universal preschool programs (Friedman-Krauss et al., 2022). The difference in development of universal preschool varies largely between countries in Europe. While countries such as France and Belgium are forerunners in universalistic preschool development, Germany as well as the U.K. are relatively hesitant to expand (public) preschools and stick to targeted programs (Scheiwe and Willekens, 2009).

Theoretically, the early investment paradigm advocated by scholars led by James Heckman is widely cited in early childhood studies, and forcefully backs the idea that

[1] Children who have access to universal preschools are eligible for preschools as long as they are born later than a certain birth date cutoff, while targeted programs are only for disadvantaged children.
[2] They are Florida, Iowa, Oklahoma, Vermont, West Virginia, Wisconsin, and DC

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early childhood investment is crucial and governments should use public policies to support early investment programs. Their concept of self-productivity indicates that development of a skill reinforces its later development, while the concept of dynamic complementarity indicates that development of one kind of skill makes later investment in another type of skill more effective (Cunha and Heckman, 2007). The arguments are mostly based on small-scale randomized early education intervention programs such as Nurse-Family Partnership (NFP), Perry Preschool program and Abecedarian (ABC) program, which provide high quality care to disadvantaged children and parenting-enhancing trainings, and thus improve children's later outcomes (e.g., crime, adult health, education attainments) by improving IQ, socioemotional skills, or parental involvement (Conti, Heckman, and Pinto, 2016; Heckman et al., 2010; Garcia et al., 2017; Heckman and Mosso, 2014; Heckman, Pinto, and Savelyev, 2013). Rigorous experimental designs of these programs guarantee superb internal validity of their effects, but limit their external validity. All of these programs recruit a small sample size of participants that are of minority races, and have socioeconomically disadvantaged background. Perry preschool and ABC additionally require participants to have low IQ. The care, home visits and training provided by these programs feature great quality, high costs, long duration, and high intensity. It raises question of how small-scale interventions can be generalized to impact the general public, and how possible it is to provide public early childcare services beyond the disadvantaged in budget constraint. Studies regarding larger-scale early education intervention programs such as Head Start (HS) and Chicago Child–Parent Center (CPC) have been separated confirmed to benefit children's secondary and college education attainments (Bailey, Sun, and Timpe, 2021), and higher income, lower rates of criminal involvement and reports of substance abuse (Reynolds et al., 2011). However, Head Start was

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implemented very differently in different sites, and CPC only targeted urban Chicago children that are disadvantaged and mostly African American.

Based on the latest TIMSS 2019 (Trends in International Mathematics and Science Study) cross-national comparison of fourth graders' Mathematics and Science test scores (presented in table A1 and A2 in the appendix), children from Japan, South Korea, Taiwan and Hong Kong are top achievers, and the standard deviations of their test scores are kept lower than their American and European counterparts. Small test scores gap of TIMSS indicates that disadvantaged children are well-prepared in advance. With mounting empirical evidences that repeatedly support the positive preschool effects on a wide array of outcomes (Magnuson, Ruhm, and Walfogel, 2007; Berlinski, Galiani, and Manacorda, 2008; Berlinski, Galiani, and Gertler, 2009), well-built early childcare infrastructure can possibly result in this spectacular success of early child learning achievements in East Asia. I argue that in sharp contrast to small-scale control experiments, Taiwan offers a great opportunity to understand consequences of providing preschools that are relatively cheap, use holistic but substantially academic-oriented curricula, and prioritize access of the disadvantaged but not exclude children from more affluent backgrounds. I evaluate preschools in Taiwan by carefully examine whether preschool attendance generate short-term impacts on various children's outcomes in this paper, including cognitive skill, noncognitive skills (social skill and aggression level), language development, and physical motor skill, which are closely related to a child's long-term development.

For the cost of attending preschools, the charging standard of different types of preschools in Taiwan are shown in table 1. Given the 2021 median yearly income of

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approximately 16900 USD in Taiwan, preschools are generally affordable. In addition to the middle-low financial costs, preschools in Taiwan are have become increasingly accessible because there has been an increase in supply of preschools while there is no recent increase in number of newborn children. The number of newborn babies is 257,866 in 2001, 166,473 in 2010, and 175,074, showing no sign of increase (Ministry of the Interior, 2020). However, as presented in table 2 and table 3, number of students enrolled in preschools, teachers, and caregivers, have increased from 2012 to 2019[3]. After entering preschool, cognitive-skill-centered curriculum may give preschool students early advantages. Although preschools in Taiwan continually have always been adopting new teaching methods, their goals have been traditionally academic-oriented and they have been perceived to be "primary school prep schools" since 1960s (Wong, 2017, pp.14, 18-19). Data also shows that preschool teachers do conduct learning activities that enhance children's school readiness. More than half of the preschool caregivers, according to the Kids in Taiwan (KIT) survey, report that they conduct learning activities such as counting, learn common words and symbols, and study English or other foreign language more than 3 to 4 times a week.

Early childhood development is postulated to be tightly related to the process of social stratification (Entwisle and Alexander, 1999). Most studies of the status attainment tradition focus on one's later period of social stratification of education, namely secondary schools and above, overlooking the gap of achievement may have formed earlier. How schools impact the intergenerational transmission process of advantage/disadvantage generally examine hypotheses of whether schools reinforce or

[3] The surge of number of preschools in 2011 is triggered by integration of preschool (for children older than age 2) and childcare center (baby-sitting facilities for children younger than age 2). Both institutions can recruit children of wider range of age afterwards

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equalize socioeconomic gap of achievements. The debate covers attendance or completion of different parts of K-12 education (Downey, von Hippel, and Broh, 2004; Brand and Xie, 2010; Zhou, 2019; Zhou, 2022), but the role of early education (child center, preschool, and kindergarten) on reducing social inequality is less investigated. One exception is Raudenbush and Eschmann's (2015) review, which preliminarily concludes that 13 of 15 studies using large samples in Europe, North America, and South America find early education benefits children who are socioeconomically disadvantaged more. Stratified school system and national standardized exams in Taiwan generate an increasing gap of achievement that is largely between schools throughout the K-12 education (Huang, 2007, 2017, 2021; Chao, 2022). Studying preschools answers whether the expansion of early education brings this school-centered process that generate inequality forward in Taiwan. Early interventions are demonstrated to be much more efficient than later remedial programs are (Heckman, 2006; Heckman, 2008). If the finding is also applicable in East Asia, early education goes beyond part of fertility policies, but a vital social security program that deals with social inequality before the disparity take roots.

Most of the studies studying preschool effects on child outcomes, the linkage between family background and child development, and how preschool impact socioeconomic inequality are based on data collected in the U.S. and European countries. Very few analyses examine these issues in the context of East Asian countries (i.e., Japan, South Korea, and Taiwan). Lack of suitable data leads to this missing piece of literature. Early childhood longitudinal data in East Asia have been absent, and aggregate learning achievement surveys that include East Asian countries do not include measures of parental income and non-academic outcomes (Raymo and Dong, 2020). The Kids in

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Taiwan (KIT) data used in this paper offers a great opportunity to solve this problem of data limitation. To my knowledge, this paper is one of the first work that utilizes a nationally representative, longitudinal survey data to examine the relationship between preschool attendance and early childhood development in East Asian countries except China (i.e., Japan, South Korea, and Taiwan).

From the policy perspective, this paper is a valuable evaluation of whether the expansion of childcare, which is at the core of pro-natalist policy in Japan, South Korea, Taiwan (Jones, 2019), meets their intended policy goals. In Taiwan, there has been a fourfold increase in government spending for children age 2 to 5 from 312000 USD in 2018 to 1.29 million USD in 2021 (Ministry of Education, 2021). The resources are used to improve the quality of preschools while lower their costs by de-privatizing preschools. Nonetheless, without little previous empirical evaluation, the impacts of preschools on children and how much the increased budget can affect preschools are largely unknown.

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Table 1. Charging Standard of Preschool Tuition in Taiwan

	Public	Semi-Public	Private
Number of Preschools (2020-2021)	2104	1262	3081
First Child	50~120 USD	Maximum 115 USD	Median: 350 USD[4] (Standard Deviation: 170 USD)
Second Child	Maximum 85 USD	Maximum 85 USD	
Third Child+	Maximum 50 USD	Maximum 50 USD	

Source: Parenting (2022); National Early Childhood Educare Website

Note: Low-income and Middle-low-income households certified by the government are eligible for full or partial discounts of tuitions and fees. For private preschools, parent(s) whose yearly household income is lower than 40900 USD are eligible for a monthly subsidy of 120 USD.

Table 2. Number of Preschool Educational Staffs in Taiwan

Year	Total	Principal	Teacher	Caregiver
2014	45,341	4,425	12,360	28,551
2015	46,169	4,339	12,291	29,537
2016	47,184	4,228	12,477	30,477
2017	49,089	4,216	12,853	32,014
2018	51,297	4,200	13,173	33,917
2019	53,747	4,271	13,698	35,772

Source: Ministry of Education (2020b)

[4] I calculate the cost of private preschools based on the information of National Early Childhood Educare Website (https://ap.ece.moe.edu.tw/webecems/pubSearch.aspx), a page set by the Ministry of Education that provides detailed information (including the costs of attendance) of preschools in Taiwan. Since it is technically difficult to access all of the information at once, I randomly choose ten private preschools for each of the 21 counties in Taiwan. If a county has less than ten private preschools, I document the costs of all of those preschools in the county. Consequently, I build a dataset of 188 private preschools, which is a representative sample of all 2245 private preschools.

The costs of private preschools are higher in Northern Taiwan, which is the most economically developed area, than the costs of other regions of Taiwan. The median value of private preschool cost is 505 USD (standard deviation: 178 USD) in Northern Taiwan, 325 USD (standard deviation: 163 USD) in Central Taiwan, 300 USD (standard deviation: 107 USD) in Southern Taiwan, and 325 USD (standard deviation: 115 USD) in Eastern Taiwan.

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Table 3. Number of Preschools and Number of Children Enrolled in Taiwan, 2000-2019

Year	Total		Public		Private	
	Number of Preschools	Number of Children Enrolled	Number of Preschools	Number of Children Enrolled	Number of Preschools	Number of Children Enrolled
2000	4,050	243,090	2,130	73,434	1,920	169,656
2001	3,234	246,303	1,288	75,956	1,946	170,347
2002	3,275	241,180	1,331	76,382	1,944	164,798
2003	3,306	240,926	1,358	74,462	1,948	166,464
2004	3,252	237,155	1,348	73,177	1,904	163,978
2005	3,351	224,219	1,474	69,186	1,877	155,033
2006	3,329	201,815	1,507	73,334	1,822	128,481
2007	3,283	191,773	1,528	73,224	1,755	118,549
2008	3,195	185,668	1,544	73,329	1,651	112,339
2009	3,154	182,049	1,553	72,991	1,601	109,058
2010	3,283	183,901	1,560	72,027	1,723	111,874
2011	3,195	189,792	1,581	71,335	1,614	118,457
2012	6,611	459,653	1,888	131,423	4,723	328,230
2013	6,560	448,189	1,919	131,910	4,641	316,279
2014	6,468	444,457	1975	135,487	4,493	308,970
2015	NA	462,115	NA	141,817	NA	320,298
2016	NA	492,781	NA	150,539	NA	342,242
2017	NA	521,904	NA	160,657	NA	361,247
2018	6,348	539,404	2,183	168,654	4,165	370,750
2019	6,384	564,545	2,257	175,723	4,127	388,822

Source: Leung and Chen (2017: p.248); Ministry of Education (2020b)

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2. Theoretical and Empirical Background

2.1. The Significance and Effectiveness of Preschools

As the first institution in a child's life that expose him/her to organized learning, a preschool teaches basic life skills, sometimes formal subjects (e.g., language, math) to prepare the child for academic success in the upcoming K-12 education, and informal learning (e.g., play and informal learning by interacting with teachers and peers).

When it comes to extension of education, most people fixate on the process and consequences of pursuing credentials of higher education, overlooking that education plays an increasingly important role in cultivate human capital and moderate inequality also by offering more people pre-primary education. The influence of early education may be even more profound than later educational attainments due to early experiences' long-lasting influences to adult cognitive, socio-emotional, and neuropsychological outcomes (Knudsen et al., 2006). Augustine, Cavanagh, and Crosnoe (2009: p.6) claim that "The middle portion of early childhood (ages 3-4) is a period in which children could benefit from more structured learning.". In general, preschool attendance is associated with higher test score gains, but with higher levels of behavioral problems at school entry (Magnuson, Ruhm, and Walfogel, 2007). The positive effect may not only benefit the child himself/herself but also generates positive spillover effect on his/her peers. (Neidell and Waldfogel, 2010). Utilizing difference of preschool program type between states and an instrumental variable (IV) design, Cascio (2021) identifies that universal preschools in the U.S. bring significantly higher test score gains than targeted preschools do, especially for economically disadvantaged kids. Similar conclusions are made for European universal preschools (Blau, 2020). In South America, preschool exposure leads to a cumulative advantage of middle school

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enrollment (Berlinski, Galiani, and Manacorda, 2008), and additional preschool space improves math test score, Spanish test score, and socio-behavioral outcomes (Berlinski, Galiani, and Gertler, 2009).

Two doubts, however, are raised on the effectiveness of preschools. First, school readiness advantage gained with preschool attendance may not persist (Duncan and Magnuson, 2013). For children attending large classes in primary schools, the positive associations between preschool attendance and test scores mostly vanishes soon after children enter elementary schools, while the adverse behavioral effects remain (Magnuson, Ruhm, and Walfogel, 2007a; Magnuson, Ruhm, and Walfogel, 2007b). Second, preschools may harm non-academic outcomes, such as increasing behavioral problems (Magnuson, Ruhm, and Waldfogel, 2007a; Li, Lv, and Huntsinger, 2014).

2.2. Skill Development from a Multi-Dimensional Perspective

A way to dissect the impact of preschool attendance on children is to examine what developmental outcomes of children are improved by preschool education. Besides so-called "cognitive skills" that are directly related (and sometimes equivalent) to test scores and academic achievements, it is essential to take other kinds of skills into consideration and discuss the relationship between skills. Examining multiple developmental outcomes at once is essential for two reasons. First, it enables researcher to compare preschools' relative contribution to different skills' development. Second, it reveals possible trade-offs of going to preschools. Magnuson, Ruhm, and Waldfogel (2007) find that while attending preschools improves test scores, it increases externalizing behavioral problems as well, similar findings are reported in China as well (Li, Lv, and Huntsinger, 2014).

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The differentiation between cognitive and noncognitive abilities is well-know, but have long been argued to be imprecise and unclear, especially on how to define and operationalize noncognitive skills. Nonetheless, social scientists generally agree that besides cognitive skills that are directly related to academic achievements, noncognitive skills are also predictive of short-term and long-term positive outcomes (Farkas, 2003). The ability to control oneself, being able to focus on the task at hand, or to cooperate with others are often considered as noncognitive skills. These "working habits" are not part of cognitive abilities, but are rewarded by teachers and employers (Bowles and Gintis, 1976: pp.131-132; Bowles and Gintis, 2002), and thus lead to improved labor market outcomes (Barrick and Mount, 1991; Fletcher, 2013) as well as later academic, psychosocial, cognitive as well as language, and health outcomes (Smithers et al., 2018). Researchers also find that most early intervention programs mainly benefit children by cultivating noncognitive skills (Kautz et al., 2014). Applying their model of skill formation, Cunha and Heckman (2008) present that earlier formation of noncognitive skills boost the later formation of cognitive skills, but the opposite is not true. Beside cognitive and noncognitive skills, I include language development and motor development as outcomes of interest, which are also related to a child's overall well-being.

2.3. Heterogeneity by Socioeconomic Status (SES) and Preschool as Equalizer that Close Gap of Social Inequalities

In the United States, wealth inequality is more serious for households with children (Gibson-Davis and Hill, 2021). Comparing to their less affluent peers, children from more affluent families are strikingly more likely to master basic kindergarten

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proficiencies such as recognizing letters, spend more time with their parents, and have higher per capita expenditures (Duncan, Magnuson, and Votruba-Drzal, 2014).

Children from affluent families have had more access to preschools than those from the poor families since 1970 in the U.S. (Duncan and Magnuson, 2013). Parents who cannot afford high-quality preschool education are more likely to use informal care instead. However, if children from less advantaged families actually gain more from preschool education than their more advantaged counterparts, preschool can still serve as an equalizer that reduces or even eliminates social equality. One possible mechanism that preschools can equalize achievement gap is to keep socioeconomically disadvantaged children away from the "household chaos" (Berry, 2016), and thus buffer the harm of chaotic home environment. The argument of school as equalizer (Downey, von Hippel, and Broh, 2004) is not new, and the role of college has been debated most heavily. The intergenerational association of occupational statuses are found to be weakest among college graduates, and strong among people without college degree and people with advanced degrees (Hout, 1988; Torche, 2011). More sophisticated analyses reach similar conclusions, but warning that selection into schools has to be carefully examined (Brand and Xie, 2010, Zhou, 2019, Zhou, 2022). In year 2000, Gamoran (2000, p.70) speculates that due to lack of public funding for preschool-aged children, preschool may be the most stratified institution among all types of childcares. However, a few more recent evidences show children from disadvantaged families gain more from going to preschool than their more affluent peers (Raudenbush and Eschmann, 2015; Berlinski, Galiani, and Manacorda, 2008, Ansari et al., 2020) indicate that preschools possibly are equalizers.

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2.4. Taiwan Context

2.4.1. Taiwan as a Typical East Asian Case

Even though the role of preschool in this region can provide valuable insights into how to give children an edge early and reduce inequality by offering relatively cheap, large-scale, but effective preschool education, relatively few works analyze preschool education in East Asia, and how preschool education affect children's development. One exception of this missing piece of studies is preschools in China, which are shown to be effective like studies based on experiences of Western societies[5]. Nonetheless, China is a lot less comparable to the other East Asian countries due to its much larger population size, relatively low per capita GDP, and distinct parent-child interaction pattern due to one-child policy (Sun and Rao, 2017, pp.20-24). Heterogeneity between states as well as differences between rural and urban (based on *hukou* status) areas also make China a very unique case that deserves to be analyzed alone.

Japan, South Korea, and Taiwan share numerous demographic and cultural patterns: high percentage of two-parent families, intensive investment on child, and fierce educational competition. They also experience a series of recent demographic changes, including late marriage, late transition into parenthood, low percentage of nonmarital childrearing, and very low total fertility rate (TFR) (Raymo et al., 2015). Taiwan has one of the world's lowest fertility rates since 2001, which recently remains at or below an astonishing figure of 1.3 to 1.4 children. As rapidly aging societies, increasing fertility rates has become one of the main goals of pro-natal family policy in

[5] Chinese children from advantaged families are more likely to attend preschools (Gong, Xu, and Han, 2014, 2016). Preschools benefit children from rural China by improving their social skills but not cognitive skills (Gong, Xu, and Han, 2016). Longer exposure or higher quality of preschool education further reinforce the positive impacts (Rao et al., 2012; Su et al., 2021; Li, Lv, and Huntsinger, 2014).

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the three countries (Coleman, 2008, pp.749-763). Parental childcare sharing and parental employment status are important factors of fertility (Raymo and Shibata, 2017; Cheng and Hsu, 2020), but the quantity and quality of childcare facilities have always been most important factors.

Another major characteristic of East Asian families is grandparental coresidence. In the early 2000s, around 40 percent of married women in southeastern China and Taiwan coresided with at least one of their husbands' parents (Chu, Xie, and Yu, 2011)[6]. Grandparental coresidence is worth taking seriously for its potentially important role of moderating intergenerational transmission of (dis)advantages. Less affluent parent(s), such as single mothers (Shirahase and Raymo, 2014), tend to coreside with the elders to save money. Grandparents can help to take care or educate their grandchildren, but the quality of grandparental care may be lower than center-based care. Evidences are mixed for whether grandparental coresidence moderates the negative impact of single parenthood on academic achievements in Japan (Raymo, 2016; Nonoyama-Tarumi, 2017; Wang and Raymo, 2020) and in Taiwan (Chen, 2016).

2.4.2 Preschools in Taiwan

Without a strict national curriculum, preschools in Taiwan are loosely regulated by the government. Traditionally, children younger than 2 years old attend childcare centers, while children age 2-6 enter preschools. Kindergartens are usually treated as a part of preschool education. Over the last two decades, 70 percent of Taiwanese children attend private preschools, while 30 percent of children attend public preschools (see table 3).

[6] Social scientists have observed that by coresidence in East Asia, grandparents may not live in the exact household where parents and children live in, but live in another proximate residence.

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Since 2019, approximately one-fourth of private preschools are transformed into semi-public preschools that are supported by the government, which have more affordable charging standards. Typically, enrollment of preschools is determined by lottery, but children that are physically or mentally challenged, indigenous, or are from economically disadvantaged families enjoy extra discounts of all fees and are prioritized to enter (semi)public preschools.

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3. Data and Measures

3.1. Data

In this paper, I use the first and second waves data of Kids in Taiwan (KIT) 36-month cohort dataset (Chang, 2019a). KIT is the first longitudinal, nationally representative database that traces children's early childhood care and development in Taiwan. Children born between April 1st, 2013 and March 31st, 2014 were interviewed roughly three years after birth (wave 1 of KIT), and interviewed again four years after birth (wave 2 of KIT). The longitudinal nature of KIT makes it a better data source compared with repeated cross-section datasets such as PISA and TIMSS, for it provides pretests and posttests of outcomes, which generate a temporal order that allows more explicit causal explanations. The KIT project uses a two-stage stratified probability proportionate to size (PPS) sampling design to collect data from residents living in main island of Taiwan, which covers approximately 99 percent of Taiwanese people. In the first sampling stage, 358 townships and districts of the country are categorized into 19 primary sampling units (PSUs)[7]. In the second sampling stage, children were selected within each PSU[8] (Chang, 2019b). The analytic sample size of KIT are 2164 children for wave 1 and 2031 children for wave 2. KIT provides information of children's health, developmental outcomes, household characteristics, childcare information, parents' socioeconomic background, and everyday parent-child interaction in great detail.

3.2. Measures

3.2.1 Outcome Variables and the Treatment Variable

The outcomes variables are Taiwanese children's developmental outcomes when they

[7] The 19 PSUs are based on indicators of aggregate demographic and economic characteristics.

[8] Residents in Hualien County and Taitung County, who account for approximately 2.3 percent of the whole population, are the only exceptions that are sampled by directly selecting individuals

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are 3 years old and 4 years old. For each wave of KIT, a child's principal caregiver reports his/her developmental outcomes[9]. Before collecting data, the KIT staffs conduct inquiries to make sure the reporters of children' s behaviors are principal caregivers who know the children the best. Most of the principal caregivers are one of the parents. Each outcome is a sum of a number of items. For each item, the principal caregiver evaluates how well a child accomplishes a task. The items are divided into several categories to measure different dimensions of an outcome (see dimensions of outcomes and description of items in table A3). For instance, "how well a child can combine two simple sentences to create a complex sentence." is an item of the dimension of language expression, and all items of three dimensions combined – language expression, language comprehension, and emergent literacy comprise the outcome of language development. As latent constructs aggregated by items, the developmental outcomes reach high internal consistencies (i.e., high level of Cronbach's alpha) between their items. Table 4 shows that using the first wave dataset of KIT, the Cronbach's alpha values of all outcomes are higher than 0.8.

The outcomes are measured by rating scales developed by Taiwanese scholars (Liu et al., 2018; Wang, Lee, and Chang, 2015; Po et al., 2016; Wang et al., 2015) which cater to Taiwanese context, child development theories, and existing assessment scales. Separated preliminary studies prove that the rating scales (BRICD, ILD, and DMSSPC) have ideal internal reliability and retest reliability. In comparison with earlier versions of child development rating scale in Taiwan[10], BRICD and ILD have good discriminant validity, construct validity, concurrent validity, and content validity (Wang, Lee, and

[9] Take the first wave dataset of KIT for example, 79.71 percent of the respondents are the child's mother, and 17.47 percent of the respondents are the child's father.

[10] The earlier reference child development rating scales are: Comprehensive Developmental Inventory for Infants and Toddlers (CDIIT) and Peabody Developmental Motor Scale 2nd Edition (PDMS-2)

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Chang, 2015; Liu et al., 2018; Po et al., 2016; Wang et al., 2015).

Table 4. Child's Developmental Outcomes, Dimensions of Items, and Internal Consistencies

Outcomes (Cronbach's Alpha)	**Dimensions**	**Rating scales**
Cognitive Skill (α=0.95)	Memory (12 items) Attention/Executive function (6 items)	Behavioral Rating Inventory of Cognitive Development for 2-5 Year Olds (BRICD)
Language Development (α=0.93)	Comprehension (3 items) Expression (9 items) Emergent Literacy (6 items)	Inventory of Language Development for 0-6 Years Old Children (ILD)
Emotional Competence (α=0.86)	Emotional Awareness (3 items) Emotional Expression (3 items) Emotional Understanding (5 items) Emotional Regulation (4 items)	
Social Competence (α=0.87)	Independence (2 items) Assertiveness (4 items) Sociability (4 items) Compliance (3 items)	
Aggression (α=0.81)		
Motor Development (α=0.98)	Gross Motor (22 items) Fine Motor (24 items)	Developmental Motor Screening Scale for Preschool Children (DMSSPC)

Cognitive skill is measured by items of ability to memorize and attend that reflect a child's overall cognitive development process. Language development is measured by summing up items of three categories for children aged 2-6 years old: comprehension,

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expression, and emergent literacy. A child that has well-developed language skills can understand words, sentences, or even simple stories, and can pronounce and speak correctly. Moreover, the child has to understand the role and distinction of language in social interactions.

As major indicators of child noncognitive skills often included in early childhood longitudinal data and studies of early childhood development, three socio-emotional outcomes are also included in this paper: social competence, emotional competence, and aggression. In general, social competence is the ability of an individual to thrive in various social situations through appropriate behaviors and perceptions of social interactions (Semrud-Clikeman, 2007). Operationalized to represent a set of desirable social skills or favorable social values (Rose-Krasnor, 1997), social competence is culturally-specific (Chen and French, 2008) and context-dependent (Semrud-Clikeman, 2007). To cater to family and cultural contexts in Taiwan, the KIT defines a socially competent child to be able to enact social actions in an independent, assertive, sociable, and compliant way. Independence measures the ability of a child to get a task done with little help from others. Assertiveness measures how good can a child express his/her feelings, suggestions, and opinions. Sociability measures the ability of a child to cooperate with and share with others. Lastly, compliance measures the extent to which a child follows adults' order. Emotional competence consists of items of four categories: emotional awareness, emotional expression, emotional understanding, and emotional regulation. An emotionally competent ("good-tempered") child can better manage their own and other people's emotion. Specifically, emotional competence measures to what extent an individual can recognize other's emotional expression, control over his/her internal state and emotional expression, express of his/her feeling, and has qualitative

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understanding of the nature of emotions. Emotional competence, especially the aspects of emotional regulation and emotional knowledge, is utterly relevant during early childhood because of its strong connection to relationship quality with peers as well as teachers, later behavioral problems, language developments, attentional competence, and cognitive ability (Garner, 2010). Additionally, I explore the impact of attending preschool on a negative socio-emotional outcome: aggression. Children with higher level of aggression tend to deride, physically attack, or ostracize their peers.

As for motor skills, two distinct types of motor skills are measured and aggregated: gross motor skills and fine motor skills. Gross motor skills involve a child's overall stability and locomotion as well as body coordination, while fine motor skills are about a child's ability to grasp, interact with objects, and perform good visual motor integration.

The treatment variable in this paper is the preschool attendance status of Taiwanese children between 3 and 4 years old. To define it with sufficient clarity[11], the treatment of attending preschool in Taiwan means that children go to preschools in the daytime for almost all of the weekdays, regardless of the preschools' types (public, private, non-profit, semi-public). Children using non-institutional childcare alternatives are comparison individuals who are take care of by preschool, parent(s), nanny, or grandparent(s). While not attending take care of them. Preschool attendance is multi-dimensional: it involves with trainings of very basic life skills such as toilet training,

[11] Defining the treatment to be sufficiently clear is essential to making the consistency assumption, which means that treatment has enough precision so that any specification of treatment does not lead to a different outcome. Hernán (2016) warns that studies analyzing ill-defined intervention (i.e., treatment) leads to confusions caused by multiple "versions" of intervention, unproductive scientific discussions, and weak linkage between the intervention and data.

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have a meal properly, and motor skill training (e.g., grabbing, running, jumping). Preschools also aim at boosting children's school readiness and interpersonal skills. Preschool attendance is conceivably manipulable. Children can possibly be assigned to or not assigned to attending preschools. I assume the classic SUTVA (Stable Unit Treatment Value Assumption) to hold, which means that treatment assignment procedures do not independently affect the outcomes. For instance, whether a child attend preschool by using the attendance quota for economically disadvantaged family or by "waiting in line" until preschool application is received does not matter. SUTVA also requires treatment assignment of one unit has no spillover effect (i.e., peer effect) to another unit. Preschool attendance status of individual *i* must not affect the decision of preschool attendance of another individual *j*.

3.2.2 Control Variables

To address biases induced by selection on (time-varying or time-invariant) observable confounders, I include a wide array of control variables, which are potentially confounders and the outcome variables (developmental outcomes). For a child's demographic variable, I adjust for child's sex and age. Since children grow rapidly, the age is documented in months rather than year to gain enough precision. Primarily following Hauser (1994)'s guidance of how to measure a child's economic well-being, I control for household income[12] as an indicator of available economic resource, maternal education (less than high school, high school/vocational school graduate,

[12] The original income survey question asks respondents to report an amount of monthly household income between no income and more than one million NTD (roughly equals to 33500 USD). I code the value of household income by taking the median of the range that the respondent chooses. For instance, if one's answer is "between 60000 and 70000 NTD", I code his/her household income as 65000NTD. Since it is unclear how much it is by "more than one million NTD", I recode the response to one million NTD. By household income, the respondent has to take salaries, pensions, rent, and any other sources of income of all family members into consideration.

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college graduate, and having an advanced degree (Master's or PhD)[13]) and mother's working status (not working, working part-time, or working full-time), which are strong predictors of patterns of early education attendance (Kulic et al.,2019).

Since children in the sample are very young, family is the primary agency of socialization. Several family characteristics are included in models, which are whether the child comes from an immigrant family, main language use at home, number of siblings, parents' marriage status, and whether the family coresides with grandparents. I also adjust for parental involvement[14] to account for behavioral patterns that cultural capital can possibly produce and reproduced. Higher level of parental involvement represents more intensive parenting style, which schools deem desirable, and thus help form cultural capital of socioeconomically advantaged children (Lareau, 1987). I calculate degree of parental involvement by adding up four standardized variables: number of children's book in a household, frequency of reading books for kids each week, length of reading books for kids each time, and a compound variable of intensive parenting behaviors[15]. As for other parents' traits, I include mother's age and whether children participate in any academic or nonacademic after-school program.

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[13] Approximately 70 percent of mothers in KIT are eligible for college (18 years old) after the massive expansion of higher education in Taiwan (1997), so both high school and college credentials are common levels of educational attainment. 42.5 percent of the mothers are high school graduates, and 40.5 percent of the mothers are college graduates.

[14] To include parental involvement in models, an option is to solely control for parental SES, for it predicts parenting style and parental involvement (Lareau, 2003; Bodovski & Farkas, 2008; Cheadle & Amato, 2011). Another crude yet widely used indicator is how many books are there in a household. By far the most related and comprehensive indicator is the NLSY HOME scale (Guo and Harris, 2000), which was used to identify high-risk families by aggregating household physical settings and cognitive as well as emotional support offered by parents.

[15] The nine items are: "I take this kid to book stores or library", "When there is activity suitable for child to join in, I participate in the activity with my child.", "I play audio books for my child.", "I use proper speech rate and tone to talk to my child.", "When talking with child, I would add a few words [to the child's sentence] or guide him/her to say more.", "I talk about things that happened before with my child, such as how we hanged out together before or what happened when my child first tried to wear a clothes on his/her own.", "When this child makes noises or speak, I respond to him/her.", "I talk to my child when I am in the middle of something.", "I think I am capable of educating my child well." [originally in Chinese, translated by the author]

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4. Analytical Strategy

4.1. Endogenous Selection into Treatment

Biases resulted from selection into preschool is the principal challenge of estimating preschool attendance effect. In observational data, individuals are not randomly assigned to preschools. Without random assignment of treatment, children who attend preschool and those who do not differ at baseline. Nonrandom selection into treatment roots in the fact that when it comes to choosing childcare, parents make decisions that maximize their and their children's gains. More socio-economically advantaged parents have more time, financial resources, and knowledge to heavily invest in their children than less affluent parents.

Uncontrolled confounders, namely the common causes of preschool attendance and child's developmental outcomes, are the main source of noncausal, spurious correlations. Researchers who fail to control for confounders can easily mistake selection into treatment for treatment effect. For instance, if socioeconomic status is not included in models, the fact that more advantaged children are more likely to attend preschool is overlooked, and the spurious correlation between attending preschool and better outcomes make researchers overestimate the positive preschool attendance effect. To address endogeneity, I utilize a research design that explicitly adopts the potential outcome framework (i.e., counterfactual framework, Rubin model), which generate estimates with less biases based on clearly-specified outcomes, a well-defined intervention (i.e., treatment), a precise estimand of interest (e.g., an average causal effect), assumptions, identification strategy, and an appropriate estimation model.

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4.2. Identification and Estimand of Difference-in-Differences (DiD) Method

To deal with endogenous selection into preschools, I take advantage of the longitudinal data and use a conventional two-period Difference-in-Differences (DiD) approach to identify the effect of preschool attendance[16]. The time binary variable has two possible values: before the policy implementation (i.e., wave 1 of KIT) or after the policy implementation (i.e., wave 2 of KIT). And the group binary variable is an indicator of whether an individual belongs to treatment group or control group. Based on the two variables, the DiD estimate can be computed with sequential differences. The first differences are subtractions of different groups' outcomes at different time points. For the treatment group, it is the difference of treatment group's values at different time points: $Y_{(Treatment,\ After)} - Y_{(Treatment,Before)}$, while for the control group, it is $Y_{(Control,\ After)} - Y_{(Control,\ Before)}$. The estimand of interest is the second difference, which is the gap between the two first differences: $\alpha_{DiD} = [Y_{(Treatment,\ After)} - Y_{(Treatment,\ Before)} - \left(Y_{(Control,\ After)} - Y_{(Control,\ Before)}\right)]$ (Card and Krueger, 1994).

Pivotal to identification of α_{DiD}, common trends assumption (i.e., parallel trends assumption) asserts that the pre-treatment trends of changes in outcomes between groups have to be the same. For the preschool attendance case, common trend assumption requires that before age 3 (i.e., the first wave data of KIT), the difference in developmental outcomes between children in the treatment group and children in the control group has to be fixed over time. Had treated children not attended preschools, their outcome development would have followed the same trajectory to that of

[16] Typically used to identify effect resulted from a policy shift, DiD features a time binary variable and a group binary variable. In this paper, preschool attendance is analogous to the policy shift that I want to evaluate.

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comparison children. Using econometric terms, the estimand that I am estimating is an average treatment effect on the treated (ATT) (Equation 1)[17]. For each potential outcome Y, the superscript denotes treatment status of potential outcome, and the subscript denotes time. Y_{it}^1 is the potential outcome for individual *i* would be treated at time t. Y_{it}^0 is the potential outcome if individual *i* would not get treatment at time t.

$$\alpha_{ATT} = \alpha_{DID} = E[Y_{i1}^1 - Y_{i0}^0 | D_i = 1] - E[Y_{i1}^0 - Y_{i0}^0 | D_i = 0]$$

$$= E[Y_{i1}^1 | D_i = 1] - (E[Y_{i0}^0 | D_i = 1] + E[Y_{i1}^0 - Y_{i0}^0 | D_i = 0])$$

$$= E[Y_{i1}^1 | D_i = 1] - E[Y_{i1}^0 | D_i = 1] \quad (1)$$

Note that the estimation of ATT only works under the common trend assumption (Equation 2):

$$E[Y_{i1}^0 - Y_{i0}^0 | D_i = 1] = E[Y_{i1}^0 - Y_{i0}^0 | D_i = 0] \quad (2)$$

The estimand is an ATT because the main idea is to construct (e.g., matching, weighting) or find a counterfactual (e.g., DiD) of the *treated* group by using the *untreated* group as a pseudo-population of the treatment group. Therefore, the target population (Lundberg, Johnson, and Stewart, 2021) is not the whole population, but the subpopulation who receive treatments ($D_i = 1$).

If the common trend assumption holds as I expect, the DiD estimation reduces noncausal associations that originates from time-invariant unobservable confounders. This is a great methodological advantage of DiD over methods only dealing with selection on observables, such as matching and weighting. A relatively strong assumption, and also a major limitation to my estimation is that since KIT data prior to

[17] Typically, for the identification strategy of DiD, it is difficult to estimate an ATE instead of ATT, for ATE is actually a weighted mean of ATT and ATC[17], and ATC estimate is usually unavailable (Lechner, 2010). Another way to claim that ATE equals to ATT is to make a strong assumption that ATT and ATC are identical. This is unlikely to be the case since the treatment is not randomly assigned.

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age 3 is unavailable, I am unable to directly test the common trends assumption, but to assume that parallel trends is the case.

4.3 Estimation

4.3.1 Group Assignment

The estimation starts by defining treatment and control group. The KIT sample is divided into four subgroups based on respondents' preschool attendance status in the first and second wave of KIT: YY, NN, YN, NY (see table 5). N represents not attending preschool, while Y represents attending preschool. For instance, if an individual belongs to the YY group, the individual reports going to preschool in both waves of KIT. If an individual belongs to the NY group, the individual does not go to preschool until second wave of KIT (i.e., when the child is 4 years old). Exploiting the variation of attendance status in two time points, the main analysis is to do the DiD estimation by treating the NY group as treatment group and the NN group as control group, thus I exclude children of YY and YN groups from my analysis.

Table 5. Preschool Attendance and Group Assignment

	Preschool Attendance		**Role**	**Observations**
	Wave 1	**Wave 2**		
Group YY	Yes	Yes	(Dropped)	348
Group NN	No	No	**Control Group**	**910**
Group NY	No	Yes	**Treatment Group**	**578**
Group YN	Yes	No	(Dropped)	23

4.3.2 The DiD model

Under the regression framework, the DiD model takes the following form:

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$$Y_{ist} = \beta_0 + \beta_1 Wave_t + \beta_2 Group_s + \beta_3 Wave_t \cdot Group_s + \beta_4 X_{ist} + \epsilon_{ist} \quad (3)$$

$Wave_t$ is a binary variable of after attending preschool, and $Group_s$ is a binary variable of being in the treatment group. $Group_s$ in equation 3 equals to 0 if an individual *i* belongs to the NN group, and it equals to 1 if *i* belongs to the NY group. The coefficient β_3 of the interaction term of the two binary variables is the estimand of interest. A positive coefficient represents a positive causal effect of preschool attendance on development outcomes. X_{ist} is a vector of individual control variables, including information of a child's family environment and personal characteristics.

Regarding the control variables, I make several assumptions. I assume positivity to hold, which requires that for every stratum of control variable, there is a positive probability to assign either treatment status to an individual. I also assume that the control variables are not posttreatment variables, which means the control variables are not themselves outcomes of the treatment. Posttreatment variables can possibly be mediators or colliders (i.e., the common outcomes of the treatment variable and the outcome variable). Adjusting for mediator blocks the causal path from treatment to outcome, and adjusting for a collider leads to endogenous selection bias (Elwert, 2013, pp.262-265; Elwert and Winship, 2014). Moreover, I assume that I have controlled for or eliminate the influence of all of the relevant confounders to assume conditional ignorability (i.e., conditional independence assumption, CIA), which signifies that the treatment assignment approximates random assignment after controlling for covariates. Formally, it can be written as:

$$(Y_i^1, Y_i^0) \perp D_i | X_i \quad (4)$$

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4.3.3 DiD Matching: Combining DiD and Propensity Score Matching (PSM)

The validity of the DiD model relies on the common trend assumption. However, if the treatment group (i.e., NY group) is not comparable to control group (i.e., NN group) at the baseline, this assumption is unlikely to hold. To address this issue, I supplement the DiD model with a propensity score matching procedure before estimation to address potential observable confounding biases between groups at baseline. This approach follows previous studies of how to combine the strengths of DiD and PSM (Blundell et al., 2004; Blundell and Dias, 2009; Stuart et al., 2014), but the DiD matching used in this paper is a slightly modified version so that it better preserves the longitudinal nature of the data[18].

For the propensity score matching, I estimate the probability of being in the treatment group (i.e., propensity score) conditional on the control variables based on a probit model, and use the kernel matching algorithm to accordingly compute propensity score weights. The kernel matching algorithm gives each treated individual a weight of one, and untreated individuals are assigned weights according to their distance to treated individuals (Garrido et al., 2014). 334 observations that fail to find matched observations are dropped. Also, I only keep the observations that have propensity scores within the overlapped range (i.e., common support) of propensity scores of treated and untreated groups, 15 observations are thus dropped. The second step of DiD matching is to estimate the conventional difference-in-differences model. The analytic sample is

[18] Earlier approaches treat the pretreatment data of the treated group as the reference population, and data of the three other groups, which are posttreatment data of the treated group, pretreatment data of the control group, and posttreatment data of the control group, are used to construct three weighted pseudo-populations as counterfactuals. In contrast, the modified DiD matching approach in this paper assigns individuals to groups based on attendance statuses of both periods, and only does propensity score matching once to balance pretreatment (i.e., before school attendance) covariates. One minor weakness of this modified approach is that it is more difficult to apply it for data more than two waves.

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a balanced panel dataset, and the standard errors are clustered based on child ID. To sum up, with the two-period DiD design, I can reduce the biases induced by time-invariant unobservable covariates. Adjusting for control variables and supplement the analysis with PSM weights in the DiD estimation reduces observable confounding biases. I assume there is no time-variant unobservable covariates between groups.

4.3.4. Treatment Intensity Model

The main model treats preschool attendance as a binary variable. However, children who go to preschools are affected to a varying extent because their duration of preschool attendance are different. While 99.6 percent of children go to preschool five days a week, hours spent at preschool each day range from 3 to 12 hours. It is possible that the model is more correctly specified by analyzing the changes in outcomes with altering intensity ("dosage") of treatment. For the treatment intensity model (Acemoglu, Autor, and Lyle, 2004; Callaway, Goodman-Bacon, and Sant'Anna, 2021), I replace the interaction term ($Wave_t \cdot Group_s$) in Equation (3) with the interaction term of before or after attending preschool ($Wave_t$) and a continuous variable $Duration_t$:

$$Y_{ist} = \beta_0 + \beta_1 Wave_t + \beta_2 Wave_t \cdot Duration_t + \beta_4 X_{ist} + \epsilon_{ist} \quad (5)$$

$Duration_t$ is the number of hours a child spends at preschool. The coefficient β_2 reflects the effect of a unit change in the duration of preschool, namely one more hour each day staying at preschool.

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5. Descriptive Statistics

Table 6 and table 7 set forth the descriptive statistics of Taiwanese children in KIT by preschool attendance status. For outcome variables, children who attend preschools have slightly better developmental outcomes than those who do not. In comparison with children who do not attend preschool, children attending preschool are less likely to coreside with grandparent(s), more likely to speak Mandarin at home, more likely to attend an after-school program, have wealthier and more educated parents, have mothers that work full time, and come from less stable families in terms of marital status.

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Table 6. Descriptive Statistics (Continuous Variables) by Preschool Attendance Status in Both Waves of KIT

	Wave 1 of KIT						Wave 2 of KIT					
	Not Attending Preschool			Attending Preschool			Not Attending Preschool			Attending Preschool		
	Freq.	Mean	Sd	Freq.	Mean	Sd	Freq.	Mean	Sd	Freq.	Mean	Sd
Outcome Variables												
Cognitive Skill	1380	39.09	12.14	342	40.81	11.97	896	50.8	11.45	855	52.23	10.35
Language Development	1380	34.7	9.27	342	35.79	9.44	896	41.16	7.96	855	42.61	7.41
Emotional Competence												
Social Competence												
Aggression	1380	2.15	2.26	342	2.17	2	896	2.12	2.35	855	2.06	2.19
Motor Development	1380	71.93	19.08	342	73.64	19.69	896	96.04	17.56	855	98.09	17.06
Individual Characteristics												
Sex (Female=1)	1380	0.49	0.5	342	0.53	0.5	896	0.49	0.5	855	0.51	0.5
Age (in months)	1380	35.94	0.68	342	36.01	0.69	896	48.07	0.7	855	48.12	0.69
Mother's Age	1380	34.22	4.58	342	34.88	4.39	896	35.16	4.62	855	35.95	4.5
Number of Siblings	1380	0.85	0.7	342	0.81	0.67	896	0.98	0.72	855	0.93	0.7
Household Income	1380	82344	83731	342	93245	68808	896	72940	47891	855	92175	76349
Ever Attending an After-School Program (Academic)	1380	0.02	0.12	342	0.04	0.21	896	0.04	0.2	855	0.09	0.28
Ever Attending an After-School Program (Non-Academic)	1380	0.09	0.29	342	0.13	0.34	896	0.23	0.42	855	0.4	0.49
Grandparent Coresidence	1380	0.57	0.5	342	0.44	0.5	896	0.56	0.5	855	0.44	0.5
Average Hours Spent on Childrearing Each Day	1380	7.4	2.22	342	6.48	1.63	896	7.48	2.12	855	6.58	1.32

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Table 7. Descriptive Statistics (Categorical Variables) by Preschool Attendance Status in Both Waves of KIT

	Wave 1				Wave 2			
	Not Attending Preschool		Attending Preschool		Not Attending Preschool		Attending Preschool	
	Freq	Percentage	Freq	Percentage	Freq	Percentage	Freq	Percentage
Immigrant Family								
Both Parents are Taiwanese	1269	91.96	324	94.74	816	91.07	806	94.27
One of the Parents is from China, HK, or Macau	56	4.06	12	3.51	40	4.46	24	2.81
One of the Parents is from Southeast Asia	49	3.55	5	1.46	34	3.79	22	2.57
One of the Parents is from other country	6	0.43	1	0.29	6	0.67	3	0.35
Total	1380	100	342	100	896	100	855	100
Child's Daily Language Use								
Mandarin	1105	80.07	334	97.66	751	83.82	835	97.66
Taiwanese, Hakka, or Aboriginal language	268	19.42	4	1.17	140	15.63	10	1.17
English or Southeast Asian Language	7	0.51	4	1.17	5	0.56	10	1.17
Total	1380	100	342	100	896	100	855	100
Maternal Education								
Less than High School	81	5.87	14	4.09	64	7.14	33	3.86
High School	617	44.71	104	30.41	406	45.31	306	35.79

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College	552	40	163	47.66	363	40.51	391	45.73
Advanced (Master's or PhD)	130	9.42	61	17.84	63	7.03	125	14.62
Total	1380	100	342	100	896	100	855	100
Type of Family Relationship								
Married	1333	96.59	323	94.44	860	95.98	818	95.67
Divorced, Seperated, or Widowed	21	1.52	12	3.51	17	1.9	22	2.57
Nonmarital Relationship	26	1.88	7	2.05	19	2.12	14	1.64
Total	1380	100	342	100	896	100	855	100
Work Full Time/Part Time (Mother)								
Not Working	554	40.14	40	11.7	374	41.74	121	14.15
Part Time (Less than 40 hrs/week)	99	7.17	27	7.89	80	8.93	74	8.65
Full Time	727	52.68	275	80.41	442	49.33	660	77.19
Total	1380	100	342	100	896	100	855	100

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6. Results

6.1. Main Analysis

For the DiD matching method, it is necessary to first check if the matching technique really balances the distribution of covariates between groups (NN as control group and NY as treatment group) before proceeding to the DiD estimation. Table A4 in the appendix, which is the two-sample t-test result, shows that for the first wave data of KIT, children in the two groups are significantly different by a wide array of variables. After dropping 348 observations that fail to find a matched observation or meet the requirement of common support of propensity score matching, the post-matching t-test results in table A5 shows that all control variables are balanced between the treatment group and the control group.

The primary regression results are presented in table 8. The standard errors are clustered by child ID, and all samples are weighted by kernel matching weights. Preschool attendance significantly improves language development, social competence, and motor development by 0.107, 0.157, and 0.117 standard deviations, which correspond to a 2.3, 4.1, and 2.9 percent increases in these three outcomes. Level of aggression is also reduced by 0.114 standard deviations, which equals to a 12.3 percent reduction decline. The impacts of preschool attendance on cognitive skill and emotional competence are not significant, therefore are indistinguishable from zero. For full regression table, see table A6 in the appendix. Overall, there seems to be no trade-offs between effects, for there are improvements in outcomes with no increase in aggression. Using the model specification that considers preschool attendance as a continuous variable, table 9 shows the results of treatment intensity model resemble the results of the main analysis. For an hour increase in hours spent at preschool each day, a child's

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language development, social competence, and motor development are improved by 0.13 to 0.19 standard deviations.

Table 8. Main Results of DiD Matching, Full Sample

	Cognitive Skill	Emotional Competence	Language Development	Social Competence	Aggression	Motor Development
$Wave_t \times Group_s$	0.048	0.030	0.107*	0.157**	-0.114†	0.117*
	(0.049)	(0.059)	(0.053)	(0.058)	(0.065)	(0.054)
Observations=2530						

Standard error in parenthesis, clustered by child ID.

All regression weighted by weights generated by kernel matching.

Significance level: †p < .10; *p < .05; **p < .01; ***p<.001 (two-tailed tests)

Table 9. Treatment Intensity Results of DiD Matching, Full Sample

	Cognitive Skill	Emotional Competence	Language Development	Social Competence	Aggression	Motor Development
$Wave_t \times Group_s$	0.003	0.007	0.015*	0.019*	-0.010	0.013*
	(0.005)	(0.007)	(0.006)	(0.007)	(0.007)	(0.006)
Observations=2530						

Standard error in parenthesis, clustered by child ID.

All regression weighted by weights generated by kernel matching.

The intensity of treatment is measured by hours spent at preschool each day.

Significance level: †p < .10; *p < .05; **p < .01; ***p<.001 (two-tailed tests)

6.2. Falsification Test

To test if the DiD design in this paper is successfully identified, I conduct a falsification

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test with children who go to preschool in both wave 1 and wave 2 of KIT (i.e., YY group) as treatment group, and children who do not go to preschool in both wave 1 and wave 2 of KIT (i.e., NN group) as control group. Since there is no change of attendance status in two time periods, the DiD research design does not work, and thus no preschool attendance effect should be detected. Any estimation of a significant effect may reflect unadjusted confounding biases. Table 10 shows that there is not any significant preschool effect under the falsification test design.

Table 10. Falsification Test Regression Results of DiD Matching, Full Sample, NN Group vs. YY Group

	Cognitive Skill	Emotional Competence	Language Development	Social Competence	Aggression	Motor Development
$Wave_t$ $\times Group_s$	-0.027	0.032	0.036	-0.028	-0.003	-0.017
	(0.067)	(0.082)	(0.072)	(0.075)	(0.083)	(0.068)
Observations=2152						

Standard error in parenthesis, clustered by child ID.

All regression weighted by weights generated by kernel matching.

Significance level: †p < .10; *p < .05; **p < .01; ***p<.001 (two-tailed tests)

6.3. Subgroup Analyses

In this section, I analyze the heterogeneity in preschool effects by household income, child's sex, and grandparental coresidence status. Since preschools may only exert their influence on particular subgroups of the full sample, estimating total effects can mask inherent heterogeneity of preschool effects. More importantly, for examining the relationship between family SES and preschool effects, if preschools benefit the

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disadvantaged more than they benefit the advantaged, preschool has profound implications of being equalizer that can close the gap of achievements. As shown in table 11, the findings are consistent with the main analysis but are only found on children who are from the households of middle 50 percent household income, households that grandparent(s) is/are present, and male. The finding that the preschool effects concentrate on children with middle income suggests a non-linear relationship between household income and preschool effects. In other words, the role of preschool in Taiwan is neither equalizer nor dis-equalizer that exclusively generate advantage for the rich. For children from families of mediocre income, attending preschool substantially improves their language development by 0.17 standard deviations (a 3.6 percent increase), social competence by 0.21 standard deviations (a 5.6 percent increase), and motor development by 0.2 standard deviations (a 4.9 percent increase).

By children's sex, the improvements of language development, social competence, and motor development are only found on boys. Additionally, preschool attendance improves boys' cognitive skill by 0.18 standard deviations (a 5.4 percent increase), and by -0.16 standard deviations (a 19.6 percent decrease), the impact of preschool attendance of reducing aggressiveness are only valid for girls. Lastly, as a potential disruptor of intergenerational transmission of (dis)advantages, I use grandparental coresidence to conduct another subgroup analysis. Slightly more than half of the children coreside with their grandparents, and grandparental coresidence possibly moderates preschool effects. It can further facilitate the positive impact of preschool education, for children are able to interact with their grandparents to practice what they have learned at school. Or growing up with grandparent(s) may simply be a substitute of attending preschool because they function similarly. Presented in table 11, preschool

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attendance only benefits children who coreside with grandparents by boosting their language development, social competence, and motor development, a finding consistent with the primary analysis. Comparing with children who do not have grandparents in their household, children coresiding with grandparents enjoy positive impacts of attending preschools. This finding may reflect the fact that having a grandparent at home can help children refine what they have learned or experienced from preschools.

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Table 11. Regression Results of DiD Matching, Divided by Subgroups

Subgroup		Cognitive Skill		Emotional Competence		Language Development		Social Competence		Aggression		Motor Development		Observations
Household Income	Top 25%	0.00	(0.10)	-0.09	(0.13)	-0.03	(0.11)	0.02	(0.13)	-0.16	(0.13)	-0.01	(0.11)	530
	Middle 50%	0.04	(0.06)	0.07	(0.07)	0.17**	(0.07)	0.21**	(0.07)	-0.13	(0.08)	0.2**	(0.07)	1570
	Bottom 25%	0.16	(0.15)	0.09	(0.16)	0.09	(0.18)	0.14	(0.15)	0.04	(0.19)	-0.01	(0.17)	430
Gender	Male	0.18*	(0.07)	0.05	(0.09)	0.16†	(0.08)	0.23**	(0.09)	-0.07	(0.10)	0.15†	(0.08)	1276
	Female	-0.07	(0.07)	0.00	(0.08)	0.06	(0.07)	0.09	(0.08)	-0.16†	(0.09)	0.09	(0.07)	1254
Grandparental Attendance Status	Coresiding with Grandparent(s)	0.06	(0.07)	0.02	(0.09)	0.17*	(0.08)	0.2*	(0.09)	-0.17†	(0.09)	0.23**	(0.08)	1394
	Not Coresiding with Grandparent(s)	0.03	(0.07)	0.05	(0.09)	0.04	(0.08)	0.12	(0.08)	-0.06	(0.10)	-0.02	(0.08)	1136

Standard errors in parentheses, clustered by child ID.

All regression weighted by weights generated by kernel matching.

Significance level: †p < .10; *p < .05; **p < .01; ***p<.001 (two-tailed tests)

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7. Discussions and Limitations

In the last decades, social scientists, developmental neuroscientists, and educational researchers have provided abundant evidences of how important early childhood development and early education are, highlighting how consequential early development is to later-life development. The literature, however, largely overlooks the role of early education, specifically the influences of preschools in East Asia. In this paper, I argue that preschools in Taiwan, which shares many cultural, institutional, and economical features of other East Asian countries, can be an inspiration of large-scale implementation of cost-effective early education. In recent years, Taiwanese parents generally find the costs of preschool decreased and the supply of preschools increased. As children's access to preschools and early education budget have greatly increased in the 2010s, Taiwanese government direly needs a comprehensive evaluation of the expansion of preschools.

Using DiD matching, treatment intensity model, and subgroup analyses, the results consistently demonstrate that attending preschool in Taiwan equally improves improvements of language development, social competence, and motor development. Some models even present a sharp reduction in aggressiveness. Intriguingly, although the preschool course contents in Taiwan have been traditionally academic-oriented, preschool attendance has no impact on cognitive skills. Since the growths of early childhood developmental outcomes are correlated, attending preschool can still indirectly benefit a child's later academic achievement.

By conducting subgroup analyses, I find that the effects are exclusively found on children who are male, have mediocre family income, and live with at least one

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grandparent. The scales of the positive effects are between 3 to 7 percent, which are slightly lower than estimates in the U.S. and Argentina (Magnuson, Ruhm, and Walfogel, 2007; Ansari et al., 2020; Berlinski, Galiani, and Gertler, 2009). These results have several crucial policy and theoretical implications. While the positive influences of preschool attendance on children is again confirmed in Taiwan, the nonlinear relationship between family SES and preschool effects questions previous preliminary findings of preschools as equalizers (Raudenbush and Eschmann, 2015). The finding that preschools only benefit children from middle-income families may be explainable by the fact that middle-class East Asian parents feel most anxious about children's development. Studies show that by carefully selecting schools and monitoring their children's development of all aspects, middle-class parents make every effort to cultivate their children's "global competitiveness" (Lan, 2018, Chp2; Lan, 2019) and hope that they can succeed in high-stake, national, standardized exams (Huang, 2017; Ho, 2009). These parents are willing to give their children an advantage when the kids are still very young. In this process, higher maternal education predicts more sophisticated preschool selection strategy and parenting practices (Yamamoto, Holloway, and Suzuki, 2006). In contrast, least advantaged parents typically do not have knowledge, time, and resource to carefully nurture their children, and the rich have less to worry about their children facing downward mobility. From policy perspective, while Taiwanese government should keep funding the expansion of preschools, it may be more crucial to carefully examine the quality of preschool programs that children from disadvantaged families attend.

The finding that going to preschool improves language development affects class reproduction. Streib (2011)'s observation of children's linguistic styles reveals that

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upper-middle-class children are rewarded to interrupt adults and to argue, overshadowing their working-class peers who have less vocabularies, and thus capture more of their teachers' attention. For less advantaged children, possessing better language skills by attending preschool can help them compete with advantaged peers. Unfortunately, this is not the case for Taiwan preschools. More future investigation is needed to check if the differences of preschool effects between groups result from any institutional, demographic, or cultural characteristics of East Asian countries.

As one common feature of East Asian families, presence of grandparent(s) at home is shown to be important to facilitating preschool effects in this paper. Another explanation of larger preschool effects when living with grandparents may originate from additional financial support that is beyond the measurement of household income (Mutchler and Baker, 2009), which keeps children from poverty status. The result that preschool only benefit boys also deserves attention. Since there is no evidence that Taiwanese preschools treat children of different sex differently, it is unclear why there is a gendered pattern of preschool effects. Future studies should explore whether this gendered difference persists, and what factor contributes to the phenomenon. Psychologists show that kindergarten teachers perceive girls to have fewer behavioral problems than boys, and that perceptional difference substantially accounts for gaps of test scores between sexes, for teachers hold higher expectations for girls than for boys (Ready et al., 2005; Robinson-Cimpian et al., 2014). If parents have similar perceptions, they may put more effort in taking care of the boys if they think boys need more help, which may explain why preschools benefit boys more.

Despite carefully measured outcomes, extensive control variables, DiD matching

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design, and falsification test are employed, there are some limitations of the analyses in this paper. First and foremost, current data lacks indicators of preschool quality and preschool type. Given how Taiwanese public preschool, private preschool, and non-profit preschool vary in infrastructure, teachers' abilities, curricula, and classroom composition, not being able to include preschool quality and preschool type restricts the possibilities of investigating mechanisms of preschool effects. One of the major findings in this paper is that preschools do not help Taiwanese children from least affluent families. Had preschool quality indicators been available, it would be possible to test if preschools do not help least affluent children because they go to preschools of low quality.

Methodologically, DiD method relies on common trend assumption to make the treatment group and control group comparable, especially on unobservable covariates. Since the information before age 3 of children in KIT data is unavailable, I am unable to formally test the assumption, which lowers the credibility of the identification of this paper.

Lastly, all analyses are based on children's information when they are three and four years old. As what I have reviewed in the background section, some scholars observe that in the U.S., the short-term gains of preschool attendance fade out after children go through primary school education. Whether this is the case in Taiwan should be investigated after more waves of KIT data are released.

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APPENDIX

Table A1. TIMSS Mathematics Test Scores Ranking of Selected Countries or Regions, Grade 4

	Mean	Rank of Mean Score	Standard Deviation (sd)	Rank of Sd in Reverse Order (Higher Rank Indicates Lower Sd)
Singapore	625	1	79	32
Hong Kong SAR	**602**	**2**	**69**	**11**
South Korea	**600**	**3**	**71**	**14**
Taiwan (Chinese Taipei)	**599**	**4**	**66**	**3**
Japan	**593**	**5**	**70**	**13**
Russian Federation	567	6	68	10
England	556	8	86	42
Norway	543	11	74	19
Austria	539	13	65	2
Netherlands	538	14	62	1
United States	535	15	85	39
Belgium (Flemish)	532	17	68	7
Finland	532	18	76	23
Denmark	525	20	73	15
Portugal	525	21	76	27
Germany	521	24	70	12
Sweden	521	25	73	17
Italy	515	28	66	4
Canada	512	32	76	22
Spain	502	37	73	16
France	485	41	80	33

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Table A2. TIMSS Science Test Scores Ranking of Selected Countries or Regions, Grade 4

	Mean	Rank of Mean Score	Standard Deviation (sd)	Rank of sd in Reverse Order (Higher Rank Indicates Lower sd)
Singapore	595	1	78	32
South Korea	**588**	**2**	**67**	**8**
Russian Federation	567	3	64	3
Japan	**562**	**4**	**69**	**14**
Taiwan (Chinese Taipei)	**558**	**5**	**65**	**4**
Finland	555	6	71	16
Norway	539	8	67	9
United States	539	9	84	40
England	537	11	71	15
Sweden	537	12	74	23
Hong Kong SAR	**531**	**15**	**71**	**17**
Canada	523	21	72	19
Denmark	522	22	68	12
Austria	522	23	74	21
Netherlands	518	26	65	6
Germany	518	28	77	29
Spain	511	30	67	11
Italy	510	32	65	5
Portugal	504	33	67	10
Belgium (Flemish)	501	35	67	7
France	488	40	78	31

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Table A3. Items of Child's Developmental Outcomes

I. Cognitive Development Questionnaire

#	Name	Description	Dimension
1	cogc01	The child plays role-playing games. For example, the child pretends to cook, or pretends that he/she is a doctor.	Memory
2	cogc02	Without any help, the child speaks out his/her age accurately on his/her own.	Memory
3	cogc03	When the child is asked about his/her gender, the child answers correctly.	Memory
4	cogc04	The child speaks out correctly two different color names.	Memory
5	cogc05	The child knows what a round shape is.	Memory
6	cogc06	The child speaks out correctly the name of his/her mother or father.	Memory
7	cogb01	The child communicates orally the meanings of objects in his/her own drawings.	Memory
8	cogc07	The child knows which book(s) he/she has read or someone has read to him/her before.	Memory
9	cogb02	The child differentiates what is alive from what is lifeless.	Memory
10	cogb03	The child counts aloud the numbers 1 to 21 in correct sequence without missing any numbers.	Memory
11	cogb04	The child states accurately the month in which he/she was born.	Memory
12	cogb05	The child understands the difference between toy money and real money.	Memory
13	cogb06	The child sketches details of a person such as hair and fingers when drawing.	Memory
14	cogb07	The child states accurately his/her home number or his/ her family's number.	Memory

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15	cogb08	The child communicates orally a make-up story.	Memory
16	cogb09	The child knows that his/her preferences are different from others.	Memory
17	cogb10	The child communicates clearly the reason why he/she likes something.	Memory
18	cogb11	The child counts aloud the numbers 1 to 100 in correct sequence without missing any numbers.	Memory
19	cogb12	The child knows that his/ her behaviors may influence others.	Attention / Executive Function
20	cogb13	When being reminded, the child slows down what he/ she is doing and does the activity better.	Attention / Executive Function
21	cogb14	The child plays or participates in puzzle game(s) or activities.	Attention / Executive Function
22	cogc08	When being asked, the child puts the toy or used object back to where it is usually placed.	Attention / Executive Function
23	cogc09	In a public place, when you ask the child to lower his/ her voice, he/she follows the instruction immediately and stays that way for at least several minutes.	Attention / Executive Function
24	cogc10	At home, when you say “no”, the child stops running or jumping immediately and stays that way for at least several minutes.	Attention / Executive Function

II. Emotional Competence Questionnaire

#	Name	Description	Dimension
1	socb06	The child feels embarrassed when he/she notices that someone is watching him/ her.	Emotional Awareness
2	socc11	The child becomes quiet when he/she notices my angry expression.	Emotional

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			Awareness
3	socc12	When the child sees someone trips or falls, he/she knows that person is in pain.	Emotional Awareness
4	socb07	The child expresses his/her feelings through words or body gestures (e.g., hugging or stamping his/her foot).	Emotional Expression
5	socb08	The child laughs when he/she hears funny jokes.	Emotional Expression
6	socb09	The child communicates to his family what he/she is afraid of.	Emotional Expression
7	socb10	The child reads other's emotions by observing that person's facial expression (e.g., when the child sees me grimacing when I take my medicine, he/she knows that the medicine tastes awful).	Emotional Understanding
8	socb11	The child knows that he/she can express the same feeling in various degrees (e.g., smiling versus laughing, sobbing quietly versus crying loudly).	Emotional Understanding
9	socb12	The child knows that he/ she can have two different kinds of feelings at the same time (e.g., playing hide-and- seek can be both fun but also scary).	Emotional Understanding
10	socc13	The child checks my facial expression to decide whether he/she should approach an unfamiliar toy or person.	Emotional Understanding
11	socc18	While encountering strangers or new environment, the child uses my facial expression as a cue to decide how he/she should behave.	Emotional Understanding
12	socb13	When the child encounters frustrating or difficult situations, he/she controls his/her temper and remains calm.	Emotional Regulation
13	socb14	When the child is scolded, he/she adjusts his/her mood and accepts the scold calmly.	Emotional Regulation
14	socb15	The child calms down himself/herself after stimulating activities.	Emotional

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			Regulation
15	socb16	The child delays his/her needs for emotional support (e.g., when the child is bullied, he/she waits for an adult to arrive before making a complaint).	Emotional Regulation

III. Language Development Questionnaire

#	Name	Description	Dimension
1	lanc01	The child can understand a simple oral instruction and follow that instruction (e.g., “Clap”).	Comprehension
2	lanc02	The child can understand two or more oral instructions and follow them in the right order (e.g., “Clap first and then touch the head”).	Comprehension
3	lanb01	The child can understand a simple joke spoken or a pun used by another person (e.g.“Where do polar bears vote? The North Poll.”).	Comprehension
4	lanc03	The child can speak out words that are used to describe a person, an event, or a thing in his/her daily life (e.g., “cold water” or “beautiful aunt”).	Expression
5	lanc04	The child can answer questions like “what is this?”(e.g., When the child is asked “what is this stuff?”, he/she can answer “a banana”; when the child is asked “what is this place?”, he/she can answer “a school”).	Expression
6	lanb02	The child can answer “why” questions (e.g., When the child is asked by an adult, “why aren't you in bed?” the child can answer “I still want to play.”).	Expression
7	lanb03	The child can combine two simple sentences to create a complex sentence (e.g., “My little brother was naughty, my mother hit him” or “The injection was painful, I didn't cry.”).	Expression

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8	lanb04	The child can combine two simple sentences to create a sentence with a conjunction (e.g., “My little brother was naughty, so my mother hit him,” or “The injection was painful, but I didn't cry.”).	Expression
9	lanb05	The child can talk about a person or a thing that is not present (e.g., when the child's bear is not in the cradle, he/she can say “my bear is gone.”).	Expression
10	lanc05	When the child talks to someone he/she is familiar with (e.g., his/her parent or teacher), he/she can initiate a topic .	Expression
11	lanc06	When the child can't understand what a person says or can't hear him/her clearly, the child can actively ask this person to clarify (e.g., “What did you just say?” or “Can you say that again?”).	Expression
12	lanb06	The child can clearly explain the procedure to complete something (e.g., the child can explain how to build a castle with toy building blocks or the rules of a game).	Expression
13	lanc07	The child knows the meanings of signs, images, and symbols which are commonly seen in his/her daily life (e.g., traffic lights or the sign of a convenient store).	Emergent literacy
14	lanc08	When the child turns over a page of a book, the direction of the book is correct (e.g., the book is not placed upside down).	Emergent literacy
15	lanc09	The child knows that the title and the name of the author/ illustrator of a picture book are on the cover of that book.	Emergent literacy
16	lanb07	When the child reads a page of a book, he/she knows where to begin (e.g., reading from left to right or reading down from the top).	Emergent literacy
17	lanb08	The child can understand or read out simple characters (e.g., his/her name or characters commonly seen in his/her daily life).	Emergent literacy

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18	lanb09	The child can express his/ her emotions and thoughts through paintings or symbols (including characters) (e.g., picture diary or a list of objects).	Emergent literacy

IV. Social Competence Questionnaire

#	Name	Description	Dimension
1	socb17	The child has the habit and attitude of "being self- reliant".	Independence
2	socb18	The child independently accomplishes what he/she can do, without prompting or support from others.	Independence
3	socb19	The child suggests games for peers to play.	Assertiveness
4	socc14	The child shows his/her interest or preference to others using his/her voices, words, gestures, or movements (e.g., he/she points to a car and looks at his/her mother with a smile).	Assertiveness
5	socc19	When the child participates in an activity or discussion, he/she expresses his/her own views or opinions without being prompted.	Assertiveness
6	socc20	The child tells others his/ her feelings without being prompted.	Assertiveness
7	socb20	The child cooperates with peers to complete a task.	Sociability
8	socb21	When the child plays with peers, he/she takes turns with the equipment or toy.	Sociability
9	socc15	The child likes to share his/ her toys with other adults or children.	Sociability
10	socc21	The child shares his/ her things (e.g., toys or stationery) with other children.	Sociability
11	socb22	The child goes to bed on time even when he/she is not yet sleepy.	Compliance
12	socb23	When the child is being requested to clean up, he/she listens and does as	Compliance

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		told.	
13	socc22	When the child is being requested to stop playing a specific game, he/she obeys and stops playing the game.	Compliance

V. Aggression Questionnaire

#	Name	Description	Dimension
1	socb27	The child damages other people's things on purpose.	Aggression
2	socb28	The child excludes other children.	Aggression
3	socb29	The child teases other children.	Aggression
4	socb30	The child kicks, hits, pushes, or pinches other children.	Aggression

VI. Physical Motor Development Questionnaire

#	Name	Description	Dimension
1	bodycg01	Can throw a ball overarm using one arm.	Gross Motor: Body Coordination
2	bodycg02	Can run steadily for a distance without falling.	Gross Motor: Stability and Locomotion
3	bodycg03	Can move his/her body with rhythm when standing.	Gross Motor: Body Coordination
4	bodycg04	Can jump in place with two legs simultaneously.	Gross Motor: Stability and Locomotion
5	bodycg05	Can slide down a slide in a sitting position on his/her own.	Gross Motor: Body Coordination

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6	bodycg06	Can climb up stairs without support.	Gross Motor: Stability and Locomotion
7	bodybg08	Can ride a tricycle.	Gross Motor: Body Coordination
8	bodycg07	Can kick a ball (Can kick a ball away from him/her in a standing position).	Gross Motor: Body Coordination
9	bodybg09	Can catch a big ball (e.g., a rubber ball) thrown by another person.	Gross Motor: Body Coordination
10	bodybg10	Can jump forward continuously (e.g., rabbit jumps).	Gross Motor: Stability and Locomotion
11	bodybg11	Can jump forward with two legs close together (e.g., a standing long jump).	Gross Motor: Stability and Locomotion
12	bodycg08	Can walk down stairs without support.	Gross Motor: Stability and Locomotion
13	bodybg12	Can ride a bicycle with two auxiliary wheels.	Gross Motor: Body Coordination
14	bodybg01	Can throw a ball toward a target that is slightly higher than the child.	Gross Motor: Body Coordination
15	bodybg02	Can do a front roll.	Gross Motor: Body Coordination
16	bodybg03	Can dance or do exercises by following a whole dance or exercise song.	Gross Motor: Body

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			Coordination
17	bodybg13	Can skip forward continuously on one foot.	Gross Motor: Stability and Locomotion
18	bodybg14	Can bounce a big ball (e.g., a rubber ball) continuously with one hand.	Gross Motor: Body Coordination
19	bodybg04	Can kick a ball toward a target (e.g., shooting a ball at a goal).	Gross Motor: Body Coordination
20	bodybg05	Can do sit-ups.	Gross Motor: Body Coordination
21	bodybg06	Can play a lattice game, including one-leg skipping and two-leg jumping forward continuously and alternately.	Gross Motor: Stability and Locomotion
22	bodybg07	Can ride a bicycle.	Gross Motor: Body Coordination
23	bodycf03	Can draw a vertical line.	Fine Motor: Visual Motor Integration
24	bodybf13	Can clap hands with rhythm (e.g., follow the music with clapping).	Fine Motor: Visual Motor Integration
25	bodycf04	Can eat with a spoon.	Fine Motor: Grasp and Manipulation
26	bodybf14	Can draw a horizontal line.	Fine Motor: Visual Motor Integration
27	bodycf05	Can turn thin pages of a storybook page by page.	Fine Motor: Grasp and Manipulation

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28	bodycf06	Can stack four or more cubic objects (e.g., building blocks or mahjong tiles).	Fine Motor: Visual Motor Integration
29	bodycf07	Can gesture the number"2" using his/her index finger and middle finger.	Fine Motor: Visual Motor Integration
30	bodycf08	Can draw a circle.	Fine Motor: Visual Motor Integration
31	bodycf01	Can take off a buttonless shirt (e.g., a t-shirt).	Fine Motor: Grasp and Manipulation
32	bodycf02	Can unbutton small buttons on his/her clothes.	Fine Motor: Grasp and Manipulation
33	bodybf01	Can screw on a bottle cap.	Fine Motor: Grasp and Manipulation
34	bodybf02	Can gesture the number"3" using his/her index, middle, and ring fingers.	Fine Motor: Visual Motor Integration
35	bodybf03	Can put on short socks.	Fine Motor: Grasp and Manipulation
36	bodybf04	Can put on a buttonless shirt (e.g., a t-shirt) independently.	Fine Motor: Grasp and Manipulation
37	bodybf05	Can button the small buttons on clothes.	Fine Motor: Grasp and Manipulation
38	bodybf06	Can brush his/her teeth.	Fine Motor: Grasp and Manipulation
39	bodybf07	Can draw a square.	Fine Motor: Visual Motor Integration
40	bodybf08	Can tie a knot.	Fine Motor: Visual

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			Motor Integration
41	bodybf09	Can draw a triangle.	Fine Motor: Visual Motor Integration
42	bodybf15	Can cut a specific shape (e.g., a circle) from a piece of paper.	Fine Motor: Grasp and Manipulation
43	bodybf16	Can fold a piece of paper to make a paper airplane.	Fine Motor: Visual Motor Integration
44	bodybf10	Can insert a zipper pin into a slider and zip up.	Fine Motor: Grasp and Manipulation
45	bodybf11	Can tie a second knot after tying the first one (e.g., tie a tight knot).	Fine Motor: Visual Motor Integration
46	bodybf12	Can eat using regular chopsticks (not learning chopsticks).	Fine Motor: Grasp and Manipulation

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Table A4. Pre-Kernel-Matching Two-Sample T-Test, Wave1

Variable	Mean		T-test		
	Treatment (NY Group)	Control (NN Group)	t-value	p-value	
Sex (Female=1)	0.50	0.47	0.99	0.321	
Age (in months)	35.94	35.91	0.82	0.414	
Mother's Age	34.42	34.09	1.31	0.191	
Immigrant Family					
One of the Parents is from China, HK, or Macau	0.02	0.04	-1.86	0.063	†
One of the Parents is from Southeast Asia	0.04	0.04	-0.18	0.857	
One of the Parents is from other country	0.01	0.01	0.46	0.642	
Child's Daily Language Use					
Taiwanese, Hakka, or Aboriginal language	0.21	0.20	0.59	0.553	
English or Southeast Asian Language	0.00	0.01	-1.86	0.063	†
Number of Siblings	0.84	0.88	-1.02	0.308	
Household Income	88169.00	75828.00	2.88	0.004	**
Maternal Education					
High School	0.39	0.45	-2.10	0.036	*
College	0.43	0.40	1.24	0.214	
Advanced (Master's or PhD)	0.13	0.07	3.78	0.000	***

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Type of Family Relationship					
Divorced, Seperated, or Widowed	0.03	0.03	0.60	0.551	
Nonmarital Relationship	0.02	0.03	-1.61	0.108	
Ever Attending an After-School Program (Academic)	0.02	0.01	2.19	0.029	*
Ever Attending an After-School Program (Non-Academic)	0.10	0.08	1.22	0.221	
Grandparent Coresidence (Coreside with at least one grandparent)	0.53	0.60	-2.56	0.011	*
Parental Involvement	0.01	-0.01	0.66	0.509	
Work Full Time/Part Time (Mother)					
Part Time (Less than 40 hrs/week)	0.06	0.07	-0.58	0.564	
Full Time	0.67	0.45	7.99	0.000	***

†p < .10; *p < .05; **p < .01; ***p<.001 (two-tailed tests)

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Table A5. Post-Kernel-Matching Two-Sample T-Test, Wave 1

Variable	Mean		T-test	
	Treatment (NY Group)	Control (NN Group)	t-value	p-value
Sex (Female=1)	0.51	0.51	0.07	0.95
Age (in months)	35.95	35.94	0.08	0.94
Mother's Age	34.45	34.37	0.26	0.80
Immigrant Family				
One of the Parents is from China, HK, or Macau	0.03	0.03	-0.19	0.85
One of the Parents is from Southeast Asia	0.03	0.03	-0.05	0.96
One of the Parents is from other country	0.01	0.01	-0.53	0.60
Child's Daily Language Use				
Taiwanese, Hakka, or Aboriginal language	0.21	0.22	-0.38	0.71
English or Southeast Asian Language	0.00	0.00	-1.40	0.16
Number of Siblings	0.83	0.83	-0.05	0.96
Household Income	89442	89157	0.05	0.96
Maternal Education				
High School	0.39	0.40	-0.27	0.79
College	0.44	0.44	0.22	0.82
Advanced (Master's or PhD)	0.13	0.13	0.28	0.78

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Type of Family Relationship				
Divorced, Seperated, or Widowed	0.02	0.02	-0.10	0.92
Nonmarital Relationship	0.01	0.01	-0.11	0.92
Ever Attending an After-School Program (Academic)	0.01	0.02	-0.49	0.62
Ever Attending an After-School Program (Non-Academic)	0.09	0.09	0.06	0.95
Grandparent Coresidence (Coreside with at least one grandparent)	0.52	0.54	-0.72	0.47
Parental Involvement	0.03	0.00	0.77	0.44
Work Full Time/Part Time (Mother)				
Part Time (Less than 40 hrs/week)	0.06	0.06	0.31	0.76
Full Time	0.67	0.67	-0.05	0.96

†p < .10; *p < .05; **p < .01; ***p<.001 (two-tailed tests)

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Table A6. Complete Regression Results of DiD Matching, Full Sample

	Cognitive Skill	Emotional Competence	Language Development	Social Competence	Aggression	Motor Development
$Wave_t \cdot Group_s$	0.048	0.030	0.11*	0.16**	-0.11†	0.12*
	(0.049)	(0.059)	(0.053)	(0.058)	(0.065)	(0.054)
$Group_s$ ($1 = NY\ group, 0 = NN\ group$)	-0.00064	-0.060	0.00055	-0.12*	0.012	-0.016
	(0.047)	(0.055)	(0.051)	(0.054)	(0.060)	(0.053)
$Wave_t$	-1.06***	0.54	-0.46	-0.021	1.27***	-0.95**
	(0.31)	(0.37)	(0.35)	(0.35)	(0.39)	(0.36)
Sex (Female=1)	0.27***	0.15**	0.20***	0.14**	-0.22***	0.26***
	(0.043)	(0.047)	(0.046)	(0.047)	(0.050)	(0.048)
Age (in months)	0.083**	-0.047	0.032	-0.0038	-0.10**	0.073*
	(0.025)	(0.030)	(0.029)	(0.029)	(0.032)	(0.029)
Mother's Age	-0.0037	-0.016**	-0.0089†	-0.021***	0.0041	-0.0060
	(0.0050)	(0.0053)	(0.0053)	(0.0053)	(0.0058)	(0.0058)

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Immigrant Family (Ref: Both Taiwanese)						
One Parent from China, HK, or Macau	-0.034	-0.20	-0.22	-0.16	-0.037	-0.034
	(0.16)	(0.17)	(0.14)	(0.14)	(0.15)	(0.14)
One Parent from Southeast Asia	-0.29†	-0.091	-0.35*	-0.10	-0.19	-0.12
	(0.16)	(0.15)	(0.15)	(0.14)	(0.12)	(0.16)
One Parent from other country	-0.93*	-0.72†	-0.78	-0.31†	-0.50†	0.030
	(0.44)	(0.42)	(0.59)	(0.18)	(0.27)	(0.35)
Child's Daily Language Use (Ref: Mandarin)						
Taiwanese, Hakka, or Aboriginal language	-0.049	0.031	-0.015	0.016	0.086	0.17**
	(0.053)	(0.057)	(0.057)	(0.055)	(0.066)	(0.057)
English or Southeast Asian Language	-0.17	0.17	0.22	0.26	-0.17	0.40*
	(0.24)	(0.29)	(0.19)	(0.28)	(0.24)	(0.18)
Number of Siblings	0.014	0.025	0.010	0.039	0.047	0.14***
	(0.030)	(0.035)	(0.038)	(0.034)	(0.031)	(0.031)

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Household Income	0.00000080**	0.00000023	0.00000049†	-0.000000067	-0.00000016	0.00000013
	(0.00000028)	(0.00000047)	(0.00000029)	(0.00000053)	(0.00000024)	(0.00000038)
Maternal Education (Ref: Less than High School)						
High School	0.23†	0.025	0.17	0.13	-0.0067	0.14
	(0.14)	(0.15)	(0.16)	(0.12)	(0.12)	(0.13)
College	0.21	-0.16	0.064	-0.020	-0.0054	-0.12
	(0.14)	(0.15)	(0.17)	(0.13)	(0.13)	(0.14)
Advanced (Master's or PhD)	0.21	-0.31†	-0.012	-0.12	0.054	-0.38*
	(0.15)	(0.17)	(0.18)	(0.15)	(0.15)	(0.15)
Type of Family Relationship (Ref: Married)						
Divorced, Seperated, or Widowed	-0.34	-0.23	-0.30	-0.14	-0.36**	-0.32
	(0.23)	(0.21)	(0.24)	(0.19)	(0.13)	(0.25)
Nonmarital Relationship	-0.33†	0.0039	-0.26	-0.00016	0.17	-0.13
	(0.18)	(0.16)	(0.22)	(0.19)	(0.21)	(0.17)

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Ever Attending an After-School Program (Academic)	0.025	0.023	0.061	0.098	0.055	0.18
	(0.096)	(0.094)	(0.099)	(0.11)	(0.14)	(0.12)
Ever Attending an After-School Program (Non-Academic)	0.11*	0.070	0.068	0.073	0.021	0.15*
	(0.048)	(0.056)	(0.047)	(0.059)	(0.062)	(0.059)
Grandparent Coresidence	0.00025	-0.057	0.0071	-0.056	0.097†	0.063
	(0.042)	(0.047)	(0.044)	(0.047)	(0.053)	(0.047)
Parental Involvement	0.69***	0.57***	0.65***	0.59***	-0.15***	0.57***
	(0.033)	(0.039)	(0.036)	(0.036)	(0.039)	(0.038)
Maternal Working Status (Ref: Not Working)						
Part Time (Less than 40 hrs/week)	0.052	-0.080	-0.0100	-0.011	0.15†	-0.062
	(0.078)	(0.089)	(0.080)	(0.086)	(0.087)	(0.085)
Full Time	0.12*	0.086	0.10†	0.10†	-0.020	0.076
	(0.050)	(0.058)	(0.056)	(0.054)	(0.059)	(0.056)
Constant	-3.30***	2.25*	-1.13	0.76	3.48**	-2.75*

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	(0.92)	(1.10)	(1.09)	(1.06)	(1.16)	(1.08)
R^2	0.3353	0.1620	0.2527	0.1752	0.0453	0.1837
N	2530					

Standard error in parenthesis, clustered by child ID.

All regression weighted by weights generated by kernel matching.

Significance level: †p < .10; *p < .05; **p < .01; ***p<.001 (two-tailed tests)

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