Daycare and Empirical Matching

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1 Daycare

This literature review focuses on daycare service provision within the context of labor economics. The primary objective of the reviewed studies is to quantitatively assess and evaluate specific policies aimed at promoting daycare accessibility and improving service quality. The evaluation criteria are derived from the original goals of childcare, which include enhancing maternal employment rates and ensuring optimal cognitive development in children. Consequently, the literature primarily employs maternal employment rates or academic achievements as outcome variables. The main policy tools employed by governments in this regard are (1) subsidies or universal access to daycare services and (2) regulatory measures targeting service providers. Accordingly, the standard research question posed is as follows: How does the provision of subsidies (or implementation of regulations) influence maternal employment (or child development)?

The daycare service market encompasses various stakeholders, as illustrated in Figure 1. The government plays a significant role in regulating the services provided and offering subsidies. Service providers, consisting of both formal and informal entities, operate within this market. The labor pool comprises individuals involved in delivering daycare services, while households with young children represent the demand side of the market. The interactions among these stakeholders are complex, necessitating the development of models to untangle the relationships and comprehend the empirical situation. However, a majority of the literature in labor economics adopts a "reduced form" approach, wherein researchers directly estimate the impact of specific policies on outcome variables. This review primarily focuses on such studies before delving into more structurally-oriented analyses.

The most cited paper in this field is Baker, Gruber and Milligan (2008) which examines the impact of the universal daycare provision in Quebec. They find that the policy increased the maternal labor supply and the use of the daycare services, while there is a robust evidence of the negative impact on the child development. I explain the basic issues in this literature following the argument of this paper.

The implementation of a subsidy or universal care system results in a reduction of daycare costs, thereby attracting increased demand from households with young children. This, in turn, facilitates greater maternal employment by alleviating the burden of parental child care responsibilities. These findings are highlighted in a study by Baker, Gruber and Milligan (2008), which reports a significant 14 percentage point increase in the proportion of children aged 0-4 years in care within the treated area. Furthermore, the study observes

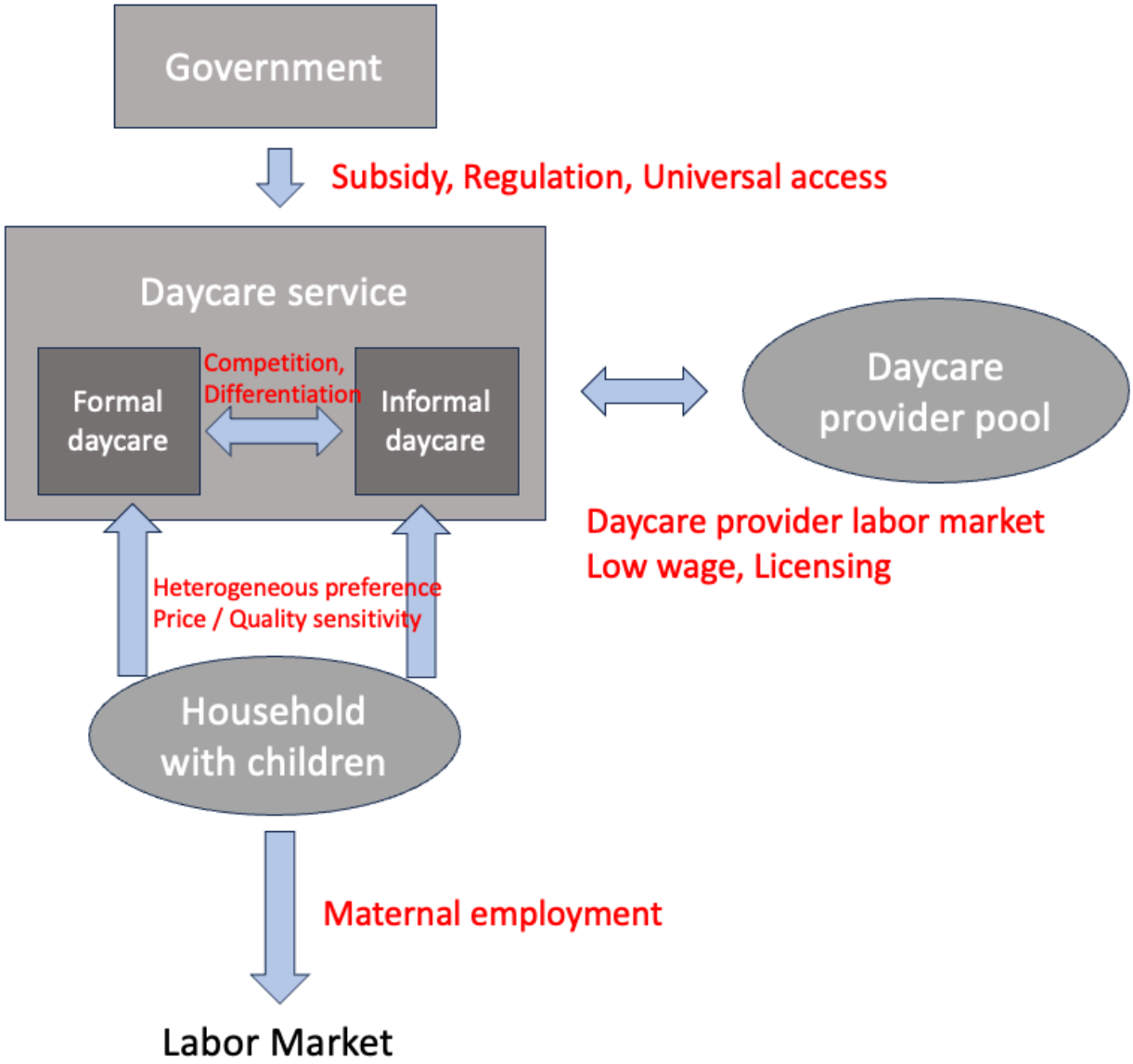

Figure 1. The universe of the daycare market.

a corresponding 7.7 percentage point increase in maternal employment specifically within Quebec. However, it is important to consider a potential caveat, as pointed out by Baker, Gruber and Milligan (2008), referred to as "crowding out" of informal daycare. This refers to the possibility that the positive impact on maternal employment may be mitigated by the substitution of formal daycare for previously utilized informal alternatives, without generating additional employment opportunities. The presence of this crowding out effect is evident in the disparity between the increase in employment and the increase in child care utilization: the former is smaller than the latter.

Havnes and Mogstad (2011) provides the evidence that this crowding out might be so huge that we cannot expect the positive impact on the maternal employment. They analyze the expansion of subsidized child care in Norway and find little causal effect of subsidized child care on maternal employment. They argue that this is due to the overwhelming crowding out. In this paper, they cite many papers studying this type of policy impact. The consistent results are in Lundin, Mörk and Öckert (2008); Cascio (2009) while the opposing results are in Baker, Gruber and Milligan (2008); Lefebvre and Merrigan (2008). The substitution pattern between the formal and the informal services are context-dependent and so we should care about the specific situation.

While the price of the daycare in the universal provision is set to 0, many policies aim to reduce the out-of-pocket cost of the households at some rate. Hence, the effect size on the maternal employment heavily depends on the price elasticity for the daycare services which the households have. There are a lot of papers estimating this elasticity, which are summarized in Blau and Currie (2006); Morrissey (2017), and the estimation results are highly variable.

In some empirical contexts, this elasticity is estimated to be sufficiently high, resulting in intense competition among service providers and necessitating the adoption of lower prices. Furthermore, as discussed in Blau (2007), competition from the informal child care sector, which operates with fewer regulations and can offer services at lower prices, as well as the challenges associated with ensuring quality in daycare services, are additional factors contributing to the lower price levels. Contrary to the prevailing anecdote of increasing childcare costs, these factors help explain the relatively lower prices observed in the daycare industry, as discussed in Herbst (2018). Moreover, these factors also shed light on the lower wages earned by daycare providers, a subject explored in the works of Blau (1992, 1993).

One possible explanation for the negative impact on the child development, found in Baker, Gruber and Milligan (2008), is this severe competition. While Baker, Gruber and Milligan (2008) highlight reduced parental involvement as the primary hindrance to development, several other studies examine competition within the daycare market and conclude that heightened competition, particularly in terms of pricing, in economically disadvantaged areas leads to a deterioration in the quality of services provided (Neilson (2021); Bodére (2023)). This intensified competition can be attributed in part to the greater price sensitivity exhibited by low-income households. Consequently, even if households possess similar preferences for educational quality, regional segregation perpetuates inequalities in access to superior services.

In response to the inequality in the quality of daycare services and the growing demand resulting from increased women's employment rates, governments have implemented regulations aimed at ensuring service quality. One common measure is the establishment of teacher-to-

child ratios, which is also implemented in Japan. Economists have undertaken rigorous analyses to quantify the effects of such regulations. A noteworthy finding is that regulations tend to reduce the number of available daycare services, as demonstrated by Blau (2007); Hotz and Xiao (2011). Building on this research, Blau (2007) examine variations in the stringency of regulations and find that stricter regulations lead to lower staff wages. This highlights the significant cost associated with such regulations. However, the effectiveness of these regulations has come under scrutiny. Gorry and Thomas (2017) argue that these regulations are merely costly without improving daycare quality, while Hotz and Xiao (2011) present contrasting evidence. It is well recognized that intangible factors play a substantial role in educational quality.

From a methodological standpoint, the literature acknowledges the potential endogeneity between child care access, pricing, and maternal employment decisions (Blau and Currie (2006)). This implies that daycare services are likely to be concentrated in areas where mothers are more inclined to continue working after childbirth, and the pricing of these services may be adjusted based on the willingness to pay of such households, which tend to have dual incomes. To address this endogeneity concern, recent studies have utilized quasi-experimental approaches to identify the impact of daycare access or pricing on maternal employment. Noteworthy examples include the works of Baker, Gruber and Milligan (2008); Havnes and Mogstad (2011); Bauernschuster and Schlotter (2015). In the case of centralized assignment mechanisms, researchers have employed tie-breaking procedures as a source of exogenous variation, akin to an "Algorithm as Experiment" approach of Narita and Yata (2021).

2 Empirical Matching

The literature on the empirical matching is initiated by Agarwal (2015), extended to the more general cases by Agarwal and Somaini (2018), and summarized in Agarwal and Somaini (2020). For the theoretical and the methodological aspects, the reader should refer to Agarwal and Somaini (2020). In this section, instead, I review the related and following papers which have the implications for the implementation of the mechanism design. It is important to acknowledge that the literature, particularly the papers focused on school matching mechanisms, typically considers only two entities as depicted in Figure 1: formal daycare and households with children. It is crucial to recognize that there are numerous external factors that influence the performance and outcomes of these mechanisms. These external factors, although not explicitly considered in the analysis, play a significant role in determining the performance of the system.

To begin with, the nice mechanism in the theoretical sense is not necessarily nice in the practical usage. Abdulkadiroğlu, Che and Yasuda (2011) provides the well-known result which states that Boston mechanism might be preferred to DA by the students because the former can exploit the cardinal preference strength among the student which is ignored in DA. In the more broader sense, Budish and Cantillon (2012) questions if strategy-proofness really benefits the economy. These papers clarifies that what mechanism is better is an empirical question. To compare several mechanism, the economists usually rely on some type of the measure of the welfare: the mechanism which generates the larger welfare in a measure

is the better one. The recent trend in this literature is to quantify the trade-off between efficiency and equity and propose mechanisms that strike a favorable balance between these two objectives. Dynamic mechanisms are examined in works such as Waldinger (2021); Agarwal et al. (2021); Verdier and Reeling (2021) while static mechanisms are addressed in Budish (2011); Sönmez and Utku Ünver (2011); Budish and Cantillon (2012); Otero, Barahona and Dobbin (2021). The distributional effect of the policy is also considered in the education policy literature Neilson (2021); Bodére (2023).

2.1 Theoretical Results

When examining the school matching mechanism, our empirical investigation centers around the choice between the Boston mechanism and the Deferred Acceptance (DA) algorithm. Prior to delving into the empirical findings, it is pertinent to review the theoretical results that determine the conditions under which each mechanism is deemed appropriate.

Remember that the notable feature of DA is its strategy-proofness: in other words, it is a dominant strategy to submit their own preferences regardless of the surrounding environment and the belief over the admission probability. The first set of the papers discuss when DA becomes manipulable.

- Fack, Grenet and He (2019) considers the mechanism called *DA with strict priority*, in which schools rank students by some priority index, e.g., a test score, which is known to students when submitting their ROL. This type of mechanism is applied in many countries to the school admission and the daycare admission process in Shibuya can be categorized into this mechanism. Under this process, the student may "skip the impossible" and choose not to apply to this school, as she rationally expects a zero admission probability based on available information such as past admission outcomes. This implies that not all students have strong incentives to rank all schools truthfully in their ROLs. In formal sense, under this mechanism, truth-telling is just a *weakly* dominant strategy. Combined with the known result about the length of the ROL by Haeringer and Klijn (2009), Fack, Grenet and He (2019) shows that, for truth-telling to be the unique equilibrium, two conditions are needed: no application cost and large uncertainty in admission outcomes.

- Arteaga et al. (2022) focus more on the problem of the length of ROL. They combine the basic search model of McCall (1970) with the school matching model to argue that the belief over the admission probability plays the critical role in deciding when to stop searching and listing the school. This implies that even in DA, the belief over the admission probability should be considered by the agents as in Boston mechanism. It is difficult to maintain the assumptions of the canonical "school choice problem" (Abdulkadiroğlu and Sönmez, 2003) that applicants know which schools are available to them and which they like when learning about schools is costly and families do not know about all of their options.

Even if the agents adopt the truth-telling behavior, strategy-proof mechanism does not necessarily generate the higher welfare than the other non-strategy-proof mechanism like Boston. The second set of papers clarifies this point.

- Abdulkadiroğlu, Che and Yasuda (2011) highlight that the Deferred Acceptance (DA) algorithm lacks the ability to fully exploit the intensity of cardinal preference in resolving tie-breakers. Consequently, in situations where school preferences are scarce, meaning that numerous students fall into the same preference group, the Boston mechanism proves more advantageous in terms of ex ante welfare compared to DA. This is achieved through the utilization of information regarding the rank assigned to each school, allowing the Boston mechanism to break ties in favor of those agents who ranked the school higher. Such scarcity of preferences is commonly observed in the context of the Boston school matching process, wherein students are primarily characterized by their school zone and sibling connections. It is worth noting that DA guarantees an optimal stable matching for students only when schools possess strict rankings over all students. Hence, from this perspective as well, the Boston mechanism is deemed inappropriate for the implementation of DA. Moreover, the authors demonstrate that even naive agents benefit from the presence of strategic players, which contrasts with the argument put forth by Pathak and Sönmez (2008). This discrepancy arises due to the strategic players' tendency not to rank highly competitive schools at the top of their preference lists, thereby leaving seats available for naive students who truthfully state their ranks.

- Budish and Cantillon (2012) analyze the course allocation mechanism in Havard Business School, called *Draft*, in which students report their preferences over individual courses to a computer which then chooses courses for them one at a time over a series of rounds: the choosing order is random in the first round, and then reverses in subsequent rounds. They show that Draft is manipulable and actually manipulated. The strategy-proof alternative which can be applied to this context is Random Serial Dictatorship, in which the students are randomly chosen and choose all the courses they want to take. They compare these two mechanisms: Ex post, RSD is Pareto efficient where Draft is not, while ex ante, large majority of the students and the social planner prefer Draft to RSD. This reversal is from the unequal treatment in RSD: "each lucky student with a good random draw makes her second, third, ..., last choices independently whether they would be some unlucky student's first choice: that is, the lucky gains less than the unlucky lose."

- Abdulkadiroğlu, Che and Yasuda (2015) have the same motivation as Abdulkadiroğlu, Che and Yasuda (2011): they want to handle the cardinal preference intensity in school assignment problem. They propose *Choice-Augmented Deferred Acceptance* (CADA) as a mechanism which uses the additional information about the strength of the preference in tie-breaking of DA. Here again they focus on the ex ante efficiency, which captures cardinal welfare, and show that CADA performs particularly well relative to DA with standard random tie-breaking rules unless either students' preferences are diverse or if the schools' priorities are strict.

- Chen and He (2021, 2022) focus on the information acquisition prior to the mechanism, like Fack, Grenet and He (2019); Arteaga et al. (2022). They show that Boston mechanism can induce the costly information acquisition about the cardinal preference intensity while DA cannot do so. As Abdulkadiroğlu, Che and Yasuda (2011, 2015)

show, this cardinal information can be exploited to increase the ex ante efficiency. Chen and He (2022) find that this welfare advantage disappears when the cost of acquiring information on own preferences passes a certain level: in other words, the results in Abdulkadiroğlu, Che and Yasuda (2011) are robust to a certain level of costly information acquisition.

The aforementioned studies provide a comprehensive analysis of the welfare implications of the Boston and Deferred Acceptance (DA) mechanisms, ultimately highlighting the advantages of the Boston mechanism in a broader context. However, it is important to consider that the social planner may also have concerns regarding equity, whereby the allocation of goods is preferred to prioritize disadvantaged agents regardless of price considerations. Although the school assignment problem does not involve explicit price considerations, it still entails equity concerns, which are addressed by a separate set of papers. Overall, these studies reach the conclusion that DA outperforms other mechanisms from an equity perspective.

- Pathak and Sönmez (2008) examine the impact of players' level of sophistication in the context of the school assignment problem. Specifically, when the Boston mechanism is employed, players are required to engage in strategic decision-making. This entails understanding the rules of the mechanism and anticipating potential manipulations by other players, and subsequently responding appropriately. Undoubtedly, this task is challenging. The authors explore an economy where both naive agents (who lack strategic sophistication) and sophisticated agents coexist, and their findings reveal that naive students experience a loss of priority compared to their sophisticated counterparts.

- Calsamiglia, Martínez-Mora and Miralles (2021) considers the robustness to the inequality of the outside options. Calsamiglia, Martínez-Mora and Miralles (2020) find that the existence of private schools that are available only for richer families will decrease the prob- ability of low and middle income families of entering the best schools in the public system. Corresponding this finding, Calsamiglia, Martínez-Mora and Miralles (2021) defines the robustness to outside option and conclude that the assignment mechanism satisfying this robustness must be ordinal, like DA. This is also related to the literature of robust mechanism design such as Bergemann and Morris (2005); Carroll (2018).

- Akbarpour et al. (2022) also focus on the inequality in the outside option. They consider the situation where the schools do not have priority over the students, which is not the case in the daycare service assignment. Their main theorem states that "A student always prefers a manipulable standard mechanism to strategy-proof mechanisms if and only if he has an outside option.", which shows that the main result presented in Abdulkadiroğlu, Che and Yasuda (2011)—an unambiguous welfare improvement from the manipulable Boston mechanisms—will not go through for all students; only students who have an outside option are guaranteed to be better off under manipulable mechanisms (and the Boston mechanism, in particular). While it depends on the preferences if the students without outside option prefers to DA, this is one supporting argument for DA usage. The intuition is as follows: in a manipulable mechanism, only the students without outside option manipulate the list to set the best school in the lower rank while the students with outside option report truthfully. This makes the seats in the best school more available to the students with outside option.

2.2 Empirical Findings

Corresponding to the above theoretical results, there are a lot of empirical papers analyzing the actual assignment mechanisms from two perspectives: (1) welfare implication and (2) equity concern. In the following subsections, I review these two strands of papers.

2.2.1 Welfare Implication

The first type of papers put a focus on the sophistication of the student side as an empirical factor deciding the performance of the mechanism. An epoch-making study by Agarwal and Somaini (2018) develops an empirical approach that does not presume truth-telling in reports or the stability condition of matching outcomes. Instead of employing inequalities derived from revealed preference arguments under such assumptions, Agarwal and Somaini (2018) describe the behavior of agents in a Bayesian Nash equilibrium. This approach allows for broader application to non-strategy-proof mechanisms such as the Boston mechanism. However, it necessitates a high level of agent sophistication, requiring them to infer the true admission probability when submitting their Rank-Order Lists (ROLs) and manipulating their reports accordingly. Hence, Agarwal and Somaini (2018) and the following papers such as Calsamiglia, Fu and Güell (2020); Kapor, Neilson and Zimmerman (2020) pay careful attention to the formation of beliefs regarding the admission probability. In particular, Kapor, Neilson and Zimmerman (2020) address this aspect using survey data and is of great significance for understanding centralized mechanisms in an empirical context, and therefore warrants a detailed review.

- Kapor, Neilson and Zimmerman (2020) analyzes the New Haven school matching mechanism. The authors use the data about the matching outcome and the author's original survey data about the preference of each household and the knowledge of the mechanism. The main empirical findings are the followings:
  - **Strategic behavior**: 32% of respondents list a school other than their stated most-preferred school (MPS) first.
    - The respondents who more strongly prefer their MPS likely list MPS first.
    - 46% of strategic students face lower odds of admission to the first listed school than their MPS.
  - The author asked the respondents to guess the probability of admission to the school ranked 1st and 2nd in two hypothetical preference lists.
    - **No change in subjective belief**: The distributions of subjective beliefs about the admission probabilities for 1st school and 2nd school are almost the same.
      - **Pessimistic on 1st ranked school**: Because the realized probability of admission is sufficiently high, *optimism* tends to be low.
      - **Optimistic on 2nd ranked school**: Because the realized probability of admission is sufficiently low, *optimism* tends to be high.
    - This implies that the respondents seems not to understand the mechanism well.

· 10.8% of respondents correctly identified the priority group.
· 20.6% of respondents correctly stated that a student rejected from her first choice school has a lower chance of admission at her second choice school than if she had ranked the second choice school first.
· 3.4% of respondents answer both of above questions correctly.
· Despite not understanding, only 5% of respondents describe the choice process as difficult.

– **Subjective belief changes the list**: The students whose belief of admission probability to his MPS when submitting the list which ranks the MPS first is higher are actually likely to rank the MPS first.
  * This leads to the increasing probability of admission to the MPS.
– **Better understanding decreases optimism**: Optimism decreases by 18% for the group stating correct answers about the questions of mechanism. And optimism decreases by 24% for the group having sibling priority which is seemingly driven by the experience of the mechanism.

Furthermore, they model the submission of preference list as Agarwal and Somaini (2018) and estimate the model using MCMC. The main innovation in the model is to handle subjective beliefs in a sense that the expected utility from getting assigned to a school is computed based on the household's subjective belief not the rational expectation belief. To achieve this, the authors also model the belief formation in which the household can make many types of errors in understanding the mechanism. In particular, the household can misunderstand the role of priority and the role of ranking systematically and the relationship between these errors are flexible.

The new thing in the estimation part is the data augmentation between the surveyed data and the mechanism data. The belief errors are estimated by the surveyed data while they can help rationalize observed choices for both surveyed and non-surveyed households.

The main findings from the structural estimation part is as follows:

– DA yields about 30% welfare improvements even if the households do not play truthfully or make short preference lists in contrast to the standard DA.
– This improvement is driven by the belief error: when we exclude the surveyed data, DA decreases the welfare compared to the baseline mechanism.
– Providing information about the mechanism, which aims to decreases the belief errors, increases the welfare regardless of mechanism is DA or baseline.

The second set of papers consider the lack of information as the key empirical factor to the mechanism behavior. Many papers find that the acquisition of information, which incurs costs, often leads to a loss in welfare. This loss can manifest in various forms, such as diminished test score value added. To examine the potential welfare gains resulting from additional information, these papers employ counterfactual analyses. Specifically, they explore information interventions or novel mechanisms that effectively leverage the

supplementary information. For instance, studies by Allende, Gallego and Neilson (2019); Arteaga et al. (2022) consider interventions like issuing warnings about the possibility of an unmatch. Ajayi and Sidibé (2020) proposes a novel mechanism that elicits individuals' preferences regarding school attributes. Another relevant study by Narita (2018) focuses on the incomplete information regarding schools. It sheds light on a scenario where some matched students express a desire to switch to a different school upon learning about the true quality of their current match. Narita (2018) proposes a new mechanism to address this potential mismatch. Collectively, these investigations reveal that these counterfactual policies effectively reduce the number of unmatches or mismatches while simultaneously improving the match quality, as evidenced by an increase in the long-term test score value added.

2.2.2 Equity Concern

Drawing from the findings presented in Akbarpour et al. (2022); Calsamiglia, Martínez-Mora and Miralles (2020), numerous empirical studies have endeavored to address the issue of equity within the domain of school matching. Kapor, Karnani and Neilson (2022) explores the presence of alternative options subsequent to the implementation of matching mechanisms. In the case of affirmative action policies, Otero, Barahona and Dobbin (2021) stands as the sole structural study that endeavors to quantitatively assess the impact of such policies within the centralized school matching framework. These works delve into specific concerns within particular contexts, thus lacking a "general" outcome to review.

3 Research Question

1. **Does "no waiting children" policy increase maternal employment?**

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