

A Service of

ZBW

Leibniz-Informationszentrum Wirtschaft Leibniz Information Centre for Economics

Sachs, Dominik; Abbott, Brant

# Conference Paper Universal versus Targeted Preschools: An Optimal Tax Approach

Beiträge zur Jahrestagung des Vereins für Socialpolitik 2016: Demographischer Wandel -Session: Tax Responses, No. E10-V3

#### Provided in Cooperation with:

Verein für Socialpolitik / German Economic Association

*Suggested Citation:* Sachs, Dominik; Abbott, Brant (2016) : Universal versus Targeted Preschools: An Optimal Tax Approach, Beiträge zur Jahrestagung des Vereins für Socialpolitik 2016: Demographischer Wandel - Session: Tax Responses, No. E10-V3, ZBW - Deutsche Zentralbibliothek für Wirtschaftswissenschaften, Leibniz-Informationszentrum Wirtschaft, Kiel und Hamburg

This Version is available at: https://hdl.handle.net/10419/145916

#### Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

#### Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



# WWW.ECONSTOR.EU

# Universal versus Targeted Preschools: An Optimal Tax Approach<sup>\*</sup>

Brant Abbott Dominik Sachs Queen's University European University Institute

February 29, 2016

#### Abstract

Many governments set up large public preschool programs in order to expand access to early education (*crowd-in*). Public preschools, however, tend to *crowd-out* private preschool enrollment. This makes such programs less cost-effective because public finances are used to pay for preschool for children that would have been in (private) preschool otherwise. Making fees for public preschools increase with family income is a way to address this trade-off. Yet this creates adverse incentives for parental labor supply. Using methods of optimal nonlinear taxation, we derive a theory of income-contingent public preschool fees that optimally trade-off crowd-in, crowd-out and parental labor supply. The optimal shape of such a fee schedule depends on labor supply elasticities, crowd-in and crowd-out elasticities as well as on the progressivity of the pre-existing income tax schedule. The more progressive the income tax schedule is, the stronger are the adverse effects of a steep preschool fee schedule on labor supply. We calibrate our model to the U.S. and use information on existing public preschool programs, enrollment rates and quasi-experimental evidence. We find that the government could increase overall preschool enrolment by 11 percentage points (19 percent) solely by targeting current subsidies more efficiently and without spending one single more dollar.

JEL-classification: H21, H23, I20, J13

Keywords: Universal Preschools, Targeted Preschools, Optimal Taxation

<sup>\*</sup>Contact: abbottbrant@gmail.com and dominik.sachs@eui.eu.

## 1 Introduction

"One solution to these problems is to make the programs universal but to offer a sliding fee schedule based on family income." Heckman (2013, p. 36)

The importance of early human capital investments has recently received substantial attention from economists and policy makers (Duncan and Magnuson 2013, Currie and Almond 2011). While much of the recent economics literature has focused on the returns to preschool and other early childhood programs, and the channels through which they work (Cunha, Heckman, and Schennach 2010, Heckman, Moon, Pinto, Savelyev, and Yavitz 2010a), policy debates have focused on how these programs ought to be implemented. In particular, the relative merits and trade-offs between universal and targeted pre-K programs are front and center in the debate (Barnett, Brown, and Shore 2004, Fitzpatrick 2008). Targeted programs – which are targeted to low income families – are considered a cost effective way to provide early education programs to the least advantaged children, but depend on arbitrary cut-off rules for participation and can incentivize parents to earn little in order to be eligible. By contrast, universal programs ensure access to early education for all children and do not disincentivize parental labor supply. However, they crowd out private parental investments leading to inefficient use of public funds (Cascio and Schanzenbach 2013). The policy question is therefore how to optimally balance crowd-in, crowd-out and work incentives for the parents.

In this paper we apply Mirrlees' (Mirrlees 1971) optimal policy approach to address this problem. Concretely, we ask which preschool policies (i) maximize the number of children going to preschool or (ii) maximize the aggregate (average) ability of all children combined, subject to an exogenous level of funding. We determine the optimal incentive-compatible allocation of children to public and private preschools. Such an allocation can then be implemented with a fee schedule for public preschools that depends on parental income. We then calibrate our model to the U.S. economy and find that an optimal income-contingent fee schedule (optimal according to (i)) can increase overall preschool enrollment by 11 percentage points (19 percent) at no additional cost to the government – this is achieved entirely by targeting subsidies more efficiently.

More concretely, we study an environment where parents differ in their ability to earn income and their preferences, which are private information. Parents make a labor supply decision and decide to send their child to (i) a public preschool, (ii) a private preschool or (iii) no preschool. How much parents work depends solely on the tax schedule in case (i) and (iii). In case (ii), the amount of hours parents work also depends on how the public preschool fee increases with income.<sup>1</sup> The steeper the fee schedule, the less they work. Parents are altruistic and value the ability of their children. Ability is endogenous with respect to preschool education. Besides ability of their children parents also value joint time with their children and are heterogeneous in that respect. Thus, if parent's preference for joint time is sufficiently strong, they might not send their child to public preschool even if it were for free. Finally, parents also differ in their status preferences concerning private or public preschool – some have a strong taste for public preschool, a public one or a private one depends on these tastes and the prices; the price for public preschool is endogenous in our analysis.

We determine optimal incentive-compatible allocations using a random participation as pioneered in Rochet and Stole (2002). We restrict the set of possible mechanisms in that we treat some allocation variables as exogenous, most importantly we take labor supply and consumption of those parents as given who do not send their children to public preschool. This is equivalent to taking the existing income tax schedule as given and generates an interesting interaction between the (endogenous) fee schedule for public preschools and the (exogenous) tax schedule. The higher the pre-existing labor supply distortion from income taxes, the higher are the efficiency costs of a steeply increasing fee schedule. Results for the optimal fee schedule therefore always depend on the pre-existing tax schedule. Theoretically, the optimal fee schedule could also be declining in parental income, in particular if the tax schedule were very progressive. As we lay out below in detail, for our calibrated economy, we find an increasing schedule to be optimal. Finally, note that we are abstracting from all redistributive concerns. Including redistributive concerns into our analysis would make the case for an increasing fee schedule even stronger.

Our focus in this work is on the implementation of a high quality program, similar to those recently introduced in Georgia and Oklahoma. Evidence on positive social returns to high quality programs exist, most famously the High/Scope Perry Preschool Program analysed by Heckman *et al.* (2010b). Evidence from other programs exists as well, as surveyed by Heckman and Mosso (2014). However, at the other end of the quality spectrum, evidence suggests that negative effects on children's outcome may occur (Baker, Gruber, and Milligan 2015). Because of this evidence that saving money by cutting program quality could detrimental, we choose to focus only on implementing a high quality program.

We calibrate our model to the U.S. and model in careful detail the current preschool policies and target current enrollment rates. The largest public preschool (or pre-K) program in the United States is Head Start. In 2014 over 925,000 three and four year old children enrolled in a Head Start program, costing just of \$8.5 million. Head Start is a truly targeted program as

<sup>&</sup>lt;sup>1</sup>We focus solely on the intensive margin of labour supply. Fitzpatrick (2010) has recently shown that public preschools indeed have little effect on mother's labor force participation despite having a strong effect on preschool enrollment.

enrollees must live in a household that is below the poverty threshold. In addition to Head Start there are various other public preschool programs, which range from state run programs that are part of the public school system to small locally run programs. About three quarters of the 36.7% of children enrolled in any form of public preschool are accounted for by non-Head Start programs. Private preschool is also an important source of early education in the US, with 20.6% of all children enrolled in a private preschool program.

Experimental and quasi-experimental studies have provided evidence on several topics related to the expansion of public preschool programs, particularly crowd-in and crowd-out responses to policy changes. We use these results to calibrate the key parameters for determining these elasticities in our model. One issue of importance is how much the introduction of a public program will crowd-out private preschool investments. Cascio and Schanzenbach (2013) use quasi-experimental variation based on the introduction of high quality universal preschool in Georgia and Oklahoma to study this. They find no evidence of crowding out of private investments among families where the mother has a High School degree or less, but find that about 40% of the increase in enrollment among children of higher educated mothers is accounted for by reduced private preschool enrollment. A related finding by Kline and Walters (2015) based on the Head Start Impact Study is that one-third of those who are randomly not offered a Head Start slot find an alternative public program to attend. Once this is accounted for there appears to be net fiscal gains from running Head Start programs through the effect of future tax revenue. This is one of many studies showing the positive benefits of early investments in children (see Heckman and Kautz (2013) for a detailed summary).

Finally, we use our theoretical framework and the calibrated model to ask the following question: How should public preschools be optimally priced in the United States? – for now we focus on the optimality criterion to maximize the number of children going to preschool. We find that the optimal public preschool fee starts at around zero for zero parental income and then increases relatively quickly. For annual parental income of \$30,000, parents already have to pay \$5,000 per year which is half of the costs. This implies an additional marginal tax rate of  $\approx 16\%$ . Afterwards, fees increase slightly less in parental income before they converge to roughly \$12,000. Compared to the current policies, enrollment rates increase across almost all income levels. Overall enrollment increases by 11 percentage points. Note that because the overall spending for public preschools is held constant, this increase in enrollment is achieved through better targeting of subsidies only.

**Related Literature.** Besides the empirical papers on preschool policies that we mentioned when describing the calibration, this paper is related to a large strand of optimal tax papers following Mirrlees (1971). In contrast to this literature, we do not consider redistribution as a goal, but rather consider a non-welfarist objective. A related paper is therefore Kanbur, Keen,

and Tuomala (1994), who consider poverty reduction as a social objective. See also Kanbur, Pirttilä, and Tuomala (2006) for a survey of related papers. Whereas this strand of literature shares the non-welfarist spirit with our paper, our paper differs in that we are not studying income taxation but use the optimal income tax approach to study optimal preschool pricing. Some recent papers in the 'New Dynamic Public Finance' tradition study implementations of second-best efficient allocations, where besides income taxes the government makes use incomecontingent repayment of student loans (Findeisen and Sachs 2015, Stantcheva 2015, Koeniger and Prat 2015). As in these papers, there are two different policy instruments that influence labor supply. Labor income taxes and some income-contingent payment – repayment of student loans in their case and payment of preschool fees in our case. Note, however, that our paper is conceptually different in that we take the labor income tax as given and focus on the design of one instrument in isolation. Whereas such an optimization of one policy instrument in isolation is naturally less ambitious in terms of the social objective, it may be of more immediate policy relevance if it is easier for governments to reform one policy instrument (preschool policies in our case) instead of changing many at the same time (which would be preschool policies and income taxes in our case).

This paper is organized as follows. In Section 2, we present our model. In Section 3 we lay out our theoretical approach to optimal policies. Section 4 contains a detailed description of our calibration, whereas we present our quantitative results for the U.S. in Section 5. Section 6 concludes.

## 2 Model

#### 2.1 Model Basics: Choices, Heterogeneity and Preferences

**Choices.** Parents make two decisions: how much to work l and where to enroll their children. Preschool enrolment decisions are denoted by  $PS \in \{no, pu, pr\}$ , where the elements of the choice set are no preschool, public preschool and private preschool, respectively. The quality of each type of preschool is denoted  $q_{PS}$ . We assume that private preschool is of the highest quality  $q_{pr}$ , and the quality of no preschool is normalized to zero, i.e.  $q_{no} = 0$ . The quality of public preschool is assumed to be  $q_{pu} \leq q_{pr}$ .

Heterogeneity. Parents are heterogeneous in three respects: ability, denoted by  $\omega \in \Omega$ , preferences for joint time with kids  $\xi \in \Xi$  and preferences for private preschool  $\phi \in \Phi$ . Ability is distributed according to cdf  $F(\omega)$  with pdf  $f(\omega)$ . The preschool preference parameter  $\phi$  is distributed conditionally on ability by  $G_{\omega}(\phi)$  with pdf  $g_{\omega}(\phi)$ .  $\xi$  is then distributed according to  $H_{\omega,\phi}(\xi)$  with pdf  $h_{\omega,\phi}(\xi)$ . The overall mass of parents is unity. Further, we assume that each parent has one child. The ability of the child depends on parent's ability and the type of preschool:  $\omega_c(\omega, q_{PS})$ .

**Preferences.** We denote parental income and consumption by y and c, respectively. The payoffs that a parent wishes to maximize are:

$$U(c - v(y,\omega)) + u^{c}(\omega_{c}(\omega, q_{PS})) + \xi \mathbb{1}_{PS=no} + \phi \mathbb{1}_{PS=pr}.$$
(1)

The first component of the payoff depends on the parent's own consumption and leisure, and the second is the altruistic payoff, which depends on the child's realized ability  $\omega_c(\omega, q_{PS})$ . Because the child's realized ability is monotonically increasing in  $q_{PS}$  (quality), the following inequality relationships hold

$$\forall \ \omega \in \Omega : \ \omega_c(\omega, q_{pr}) \ge \omega_c(\omega, q_{pu}) > s\omega_c(\omega, 0)$$

#### 2.2 Equilibrium given Policies

In our environment there are two policy instruments: (i) labor income taxes T(y) and (ii) public preschool fees  $F_{pu}(y)$ . We treat the labor income tax schedule as exogenous and focus on the optimal design of the public preschool fee schedule.

The problem of a parent given these schedules reads as:

$$V(\omega, \phi, \xi) = \max_{y, ps \in \{no, pu, pr\}} U(c - v(y, \omega)) + u^{c} (\omega_{c}(\omega, q_{ps})) + \mathbb{1}_{ps = pr} \phi + \mathbb{1}_{ps = no} \xi$$
  
s.t.  $c \leq y - T(y) - F_{pr} \mathbb{1}_{ps = pr} - F_{pu}(y) \mathbb{1}_{ps = pu},$ 

where we treat the private preschool fee  $F_{pr}$  as exogenous. The first-order condition for labor supply reads as:

$$1 - T'(y) - F'_{pu}(y)\mathbf{1}_{ps=pu} - v_y(y,\omega) = 0.$$

If the child is enrolled in public preschool, the effective marginal tax rate is equal to  $T'(y) - F'_{pu}(y)$  and not only T'(y) – this formally captures that fees that increase with income disincentivize parents at the labor supply margin.

We now turn to the preschool choice. One can easily show that the it can be summarized by the following lemma, where we denote by  $V_{pu}(\omega, \phi, \xi), V_{pr}(\omega, \phi, \xi), V_{no}(\omega, \phi, \xi)$  the indirect utility function conditional on preschool choice.

**Lemma 1.** The preschool choice of an individual of type  $(\omega, \phi, \xi)$  in the presence of an income tax schedule T(y), a private preschool fee  $F_{pr}$  s and an income-contingent public preschool fee schedule  $F_{pu}(y)$  can be summarized by

- $ps(\theta, \phi, \xi) = pr \text{ if } \phi \geq \tilde{\phi}(\omega) \text{ and } \xi < \tilde{\xi}(\omega, \phi)$
- $ps(\theta, \phi, \xi) = pu \text{ if } \phi < \tilde{\phi}(\omega) \text{ and } \xi < \tilde{\xi}(\omega, \phi)$
- $ps(\theta, \phi, \xi) = no \ if \ \xi \ge \tilde{\xi}(\omega, \phi) \ ,$

where the threshold functions are defined by

$$\forall \,\omega,\phi: U\left(c_{no}(\omega) - v(y_{no}(\omega),\omega)\right) + u^{c}(\omega_{c}(\omega,0)) + \tilde{\xi}(\omega,\phi) = \max\left(V_{pu}(\omega,\phi,\xi), V_{pr}(\omega,\phi,\xi)\right).$$
(2)

and

$$\forall \, \omega : U \left( c_{pr}(\omega) - v(y_{pr}(\omega), \omega) \right) + u^{c}(\omega_{c}(\omega, q_{pr})) + \tilde{\phi}(\omega) =$$

$$U \left( c_{pu}(\omega) - v(y_{pu}(\omega), \omega) \right) + u^{c}(\omega_{c}(\omega, q_{pu}))$$
(3)

respectively.

### **3** Optimal Preschool Policies

We state the government's objective and constraints in Sections 3.1 and 3.2 respectively. In Section 3.3, we discuss the concept of marginal tax rates, wedges and marginal preschool fees. In Section 3.4, we derive the optimal public preschool fee schedule.

#### 3.1 Government's Objective

We consider two different objectives of the social planner. First, we consider the case where the planner's objective is some transformation over children's abilities. Second, we consider the case where the planner wants to minimize the number of children without any preschool education.

Ability Objective In this case, the planner maximizes

$$\int_{\Omega} \int_{\underline{\phi}}^{\tilde{\phi}(\omega)} \left( W(\omega_{c}(\omega,0)) \left( 1 - H_{\omega,\phi}(\tilde{\xi}(\omega,\phi)) \right) + W(\omega_{c}(\omega,q_{pu})) H_{\omega,\phi}(\tilde{\xi}(\omega,\phi)) \right) dG_{\omega}(\phi) \\
+ \int_{\tilde{\phi}(\omega)}^{\overline{\phi}} \left( W(\omega_{c}(\omega,0)) \left( 1 - H_{\omega,\phi}(\tilde{\xi}(\omega,\phi)) \right) + W(\omega_{c}(\omega,q_{pr})) H_{\omega,\phi}(\tilde{\xi}(\omega,\phi)) \right) dG_{\omega}(\phi) dF(\omega). \quad (4)$$

In the special case where W(x) = x, the planner wants to maximize average ability of children. Another interesting case is, where W'' < 0. In this case the government also has equity concerns for ability.

**Number of Children Objective** In this case, the planner minimizes the share of kids without any preschool education

$$\int_{\Omega} \int_{\Phi} \left( 1 - H_{\omega,\phi}(\tilde{\xi}(\omega,\phi)) \right) dG_{\omega}(\phi) dF(\omega).$$
(5)

#### 3.2 Government's Constraints

The government budget constraint reads:

$$\int_{\Omega} \left( T(y(\omega)) \left[ \int_{\tilde{\phi}(\omega)}^{\overline{\phi}} H_{\omega,\phi}(\tilde{\xi}(\omega,\phi)) dG_{\omega}(\tilde{\phi}(\omega)) + \int_{\underline{\phi}}^{\overline{\phi}} \left( 1 - H_{\omega,\phi}(\tilde{\xi}(\omega,\phi)) \right) dG_{\omega}(\tilde{\phi}(\omega)) \right] \\
+ \left[ \int_{\underline{\phi}}^{\tilde{\phi}(\omega)} H_{\omega,\phi}(\tilde{\xi}(\omega,\phi)) dG_{\omega}(\tilde{\phi}(\omega)) \right] \{ T(y_{pu}(\omega)) + F_{pu}(y_{pu}(\omega)) - \mathcal{C}q_{pu} \} \right) dF(\omega) \ge R. \quad (6)$$

The first line captures tax revenue from all individuals that do not send their kids to public preschool. The second line captures the public preschool parents. In addition to taxes, the government also obtains fees from them. However, each child in public preschool also implies resource costs for the government, that are denoted by  $Cq_{pu}$ ; thus we assume constant marginal costs for the public preschool.

To write down the government's problem in a tractable way, we make a change of variables and write the above government budget constraint as:

$$\int_{\Omega} \left( T(y(\omega)) \left[ \int_{\tilde{\phi}(\omega)}^{\overline{\phi}} H_{\omega,\phi}(\tilde{\xi}(\omega,\phi)) dG_{\omega}(\tilde{\phi}(\omega)) + \int_{\underline{\phi}}^{\overline{\phi}} \left( 1 - H_{\omega,\phi}(\tilde{\xi}(\omega,\phi)) \right) dG_{\omega}(\tilde{\phi}(\omega)) \right] \\
+ \left[ \int_{\underline{\phi}}^{\tilde{\phi}(\omega)} H_{\omega,\phi}(\tilde{\xi}(\omega,\phi)) dG_{\omega}(\tilde{\phi}(\omega)) \right] \left\{ y_{pu}(\omega) - c_{pu}(\omega) - \mathcal{C}q_{pu} \right\} \right) dF(\omega) \ge R.$$
(7)

Thus, we got rid of  $F_{pu}(\cdot)$  and introduced  $c_{pu}(\omega)$ . The government now optimizes over  $\{y_{pu}(\omega), c_{pu}(\omega)\}_{\omega \in \Omega}$  directly instead of optimizing over  $F_{pu}(\cdot)$ , i.e. we follow a primal approach.

Taking into account individual behavior Note, that  $y_{no}(\omega)$  and  $y_{pr}(\omega)$  are actually exogenous as they only depend on  $\omega$  and the tax function, which we take as exogenous. Thus, when choosing  $\{y_{pu}(\omega), c_{pu}(\omega)\}_{\omega \in \Omega}$ , the government only has to take into account that  $y_{pu}(\omega)$  is also the individually optimal labor supply decision of public preschool parents and how the thresholds  $\tilde{\xi}(\omega, \phi)$  and  $\tilde{\phi}(\omega)$  respond.



Figure 1: Perturbation of Public Preschool Fee Schedule

Let us start with the former. Following common practices in the theory of optimal income taxation in the tradition of Mirrlees (1971), one can show that the optimality condition for labor supply can be written as an incentive compatibility constraint, which in turn can be summarized by:

$$\forall \omega, \xi \leq \tilde{\xi}(\omega, \phi), \phi \leq \tilde{\phi}(\omega): \ \frac{\partial V_{pu}(\omega, \phi, \xi)}{\partial \omega} = U'v'\frac{y}{\omega^2}$$

and a monotonicity constraint  $y'_{pu}(\omega) \ge 0$  which we ignore in the analytical part as is common practice in the literature.

Finally we also have to take into account that the threshold functions are implicitly given by (2) and (3). In Appendix A.1 we present a derivation of the optimal fee schedule using mechanism-design techniques. In the main body of the paper, we use a more intuitive perturbation approach in the spirit of Piketty (1997) and Saez (2001).

#### 3.3 Wedges, Marginal Tax Rates and Marginal Preschool Fees

The total labor wedge is the sum of the marginal preschool fee and the marginal income tax rate:

$$\tau_{pu}(\omega) = F_{pu}(y_{pu}(\omega)) + T'(y_{pu}(\omega)).$$
(8)

Since the wedge measures the distortion of the labor supply decision and we take the income tax schedule as given, the costs of having a steeply increasing preschool fee schedule will depend on the progressivity of the income tax schedule.

#### 3.4 The Optimal Fee Schedule

Assume that the preschool fee schedule in Figure 1 is the optimal preschool fee schedule. Then, slightly perturbing it as illustrated should have no first-order effect on welfare. Note that the perturbation is such that the marginal preschool fee is slightly increased by  $dF'_{pu}$  in an infinitesimal interval around  $y_{pu}(\omega^*)$  with length dy.

Mechanical Revenue Effect All public preschool parents with  $\omega > \omega^*$  will now pay  $dF'_{pu}dy$  dollars more of fees. Denote by  $\lambda$  the marginal value of public funds. The impact on the governments objective thus is

$$dW_{mech} = \lambda dF'_{pu} dy \times \int_{\omega^*}^{\overline{\omega}} \int_{\underline{\phi}}^{\tilde{\phi}(\omega)} H_{\omega,\phi}(\tilde{\xi}(\omega,\phi)sdG_{\omega}(\phi)dF(\omega),$$

where the double integral captures the mass of parents with ability above  $\omega^*$  that send their child to a public preschool.

**Labor Supply Effect** All public preschool parents with income  $y_{pu}(\omega^*)$  now face a higher (implicit) marginal tax rate. They will change their behaviour according to

$$\frac{\partial y_{pu}(\omega^*)}{\partial \tau} dF'_{pu} = \varepsilon_{y,1-\tau} \frac{y_{pu}(\omega^*)}{1-\tau(\omega^*)} dF'_{pu}.$$

The labor supply response of these parents has no first-order effect on welfare because of the envelope theorem. However, it influences welfare through the implied change of marginal funds. Of each marginally earned dollar, the government obtains  $\tau(\omega^*)$ . Per individual, the effect on the government's objective is given by:

$$\tau(\omega^*)\varepsilon_{y,1-\tau}\frac{y_{pu}(\omega^*)}{1-\tau(\omega^*)}dF'_{pu}.$$
(9)

How many individuals are there that change their labor supply?

$$\int_{\underline{\phi}}^{\phi^*} H_{\omega,\phi}(\tilde{\xi}(\omega^*,\phi)) dG_{\omega}^*(\phi) \times f(\omega^*) d\omega = \int_{\underline{\phi}}^{\phi^*} H_{\omega,\phi}(\tilde{\xi}(\omega^*,\phi)) dG_{\omega}^*(\phi) \times f(\omega^*) \frac{dy}{\varepsilon_{y,\omega}} \frac{\omega^*}{y(\omega^*)}$$

Multiplying the effect per individual (9) with the mass of individuals yields the overall effect on welfare of this implied labor supply change:

$$dW_{labor}(\omega^*) = \lambda \frac{\tau(\omega^*)}{1 - \tau(\omega^*)} \varepsilon_{y,1-\tau} \omega^* \frac{1}{\varepsilon_{y,\omega}} \times \int_{\underline{\phi}}^{\phi^*} H_{\omega,\phi}(\tilde{\xi}(\omega^*,\phi)) dG_{\omega}^*(\phi) f(\omega^*) \times dy dF_{pu}'.$$

**Preschool Dropout Effect** Some public preschool parents with  $\omega > \omega^*$  have been indifferent between sending their children to public preschool and to no preschool at all. Namely, all individuals with altruism  $\xi = \tilde{\xi}(\omega, \phi)$  and  $\phi < \tilde{\phi}(\omega)$ . Because of this increase in preschool fees they will now decide not to send their child to preschool anymore. The mass of kids that drops out for each  $\omega > \omega^*$  is given by (using Leibnitz rule)

$$\forall \, \omega \ge \omega^* : \Delta \operatorname{Drop}(\omega) = -\int_{\underline{\phi}}^{\tilde{\phi}(\omega)} h(\tilde{\xi}(\omega, \phi)) \frac{\partial \tilde{\xi}(\omega, \phi)}{\partial F_{pu}} dy dF'_{pu} dG_{\omega}(\phi) f(\omega).$$

First, this change in behavior has a direct impact on the governments objective because these children will now have a lower ability

$$dW_{dropout-direct}(\omega^*) = \int_{\omega^*}^{\overline{\omega}} \left( W(\omega_c(\omega, 0)) - W(\omega_c(\omega, q_{pu})) \right) \Delta \operatorname{Drop}(\omega) d\omega.$$

Second, it also has an impact on the government budget. The contribution to the government budget of each individual that drops out changes by

$$\Delta T(\omega) = T(y(\omega)) - T(y_{pu}(\omega^*)) + R_{pu} - F_{pu}(y_{pu}(\omega^*))$$
$$dW_{dropout-budget}(\omega^*) = \lambda \int_{\omega^*}^{\overline{\omega}} \Delta T(\omega) \Delta \operatorname{Drop}(\omega) d\omega.$$

**Crowd-in Effect** Some public preschool parents with  $\omega > \omega^*$  have been indifferent between sending their children to public preschool or to private preschool. Namely, all individuals with  $\phi = \tilde{\phi}(\omega)$  and  $\xi < \tilde{\xi}(\omega, \phi)$ . Because of this increase in preschool fees they will now decide to send their child to private preschool instead. The mass of kids that change to private preschool for each  $\omega > \omega^*$  is given by (using Leibnitz rule)

$$\forall \, \omega \geq \omega^* : \Delta \text{Crowd-in} \, (\omega) = -\frac{\partial \tilde{\phi}(\omega)}{\partial F_{pu}} dy dF'_{pu} H(\tilde{\xi}(\omega, \tilde{\phi}(\omega))) f(\omega)$$

This has a direct impact on the government's objective if  $\omega_c(\omega, q_{pr}) \neq \omega_c(\omega, q_{pu})$ .

$$dW_{crowd-in-direct} = \int_{\omega^*}^{\overline{\omega}} \left( W(\omega_c(\omega, q_{pr})) - W(\omega_c(\omega, q_{pu})) \right) \Delta \text{Crowd-in}(\omega) d\omega.$$

It will also change individual contributions to the government's budget. Each switcher will have an impact of  $\Delta T(\omega)$  on the government's budget. Thus the overall crown-in effect on through public funds is

$$dW_{crowd-in-budget} = \lambda \int_{\omega^*}^{\overline{\omega}} \Delta T(\omega) \Delta \text{Crowd-in}(\omega) dF(\omega).$$

**Optimality** If the fee schedule is optimal, the sum of the welfare effects has to be zero, thus the necessary condition for an optimal public preschool fee schedule are:

$$\forall \omega \in \Omega : dW_{mech}(\omega) + dW_{labor}(\omega) + dW_{dropout-direct}(\omega) + dW_{dropout-budet}(\omega) + dW_{crowd-in-direct}(\omega) + dW_{crowd-in-budet}(\omega) = 0$$
(10)

Rearraning (10) yields the following proposition:

**Proposition 1.** Optimal labor wedges (according to (4) for parents who send their kids to public preschool are given by:

$$\frac{\tau_{pu}(\omega)}{1-\tau_{pu}(\omega)} = \left(1 + \frac{1}{\varepsilon(\omega)}\right) \frac{\mu(\omega)}{\lambda \int_{\underline{\phi}}^{\tilde{\phi}(\omega)} H_{\omega,\phi}(\tilde{\xi}(\omega,\phi)) dG_{\omega}(\phi) f(\omega)\omega},$$

where

$$\begin{split} \mu(\omega) &= \int_{\omega}^{\overline{\omega}} \left( \lambda \left[ f(\omega) \int_{\underline{\phi}}^{\tilde{\phi}(\omega)} H_{\omega,\phi}(\tilde{\xi}(\omega,\phi) dG_{\omega}(\phi) + \Delta T(\omega) \left( \Delta Drop(\omega) + \Delta Crowd\text{-}in(\omega) \right) \right] \\ &+ \left( W(\omega_c(\omega,0)) - W(\omega_c(\omega,q_{pu})) \right) \Delta Drop(\omega) \\ &+ \left( W(\omega_c(\omega,q_{pr})) - W(\omega_c(\omega,q_{pu})) \right) \Delta Crowd\text{-}in(\omega) \right) d\omega. \end{split}$$

and  $\lambda$  is implicitly defined by  $\mu(\underline{\omega}) = 0$ .

This condition for the optimal labor wedge trades-off the labor supply margin, the public/private preschool margin and the public/no preschool margin. It is formally similar to conditions for optimal redistributive taxes such as in Diamond (1998) and Jacquet, Lehmann, and Van der Linden (2013). The motives for labor supply distortions here, however, are very different. The redistribution motive here is shut down. The motive at work is to maximize (4). If the social objective is (4), it is easy to show that optimal wedges are described by the following corollary.

**Corollary 1.** Optimal labor wedges (according to (5) for parents who send their kids to public preschool are given by:

$$\frac{\tau_{pu}(\omega)}{1-\tau_{pu}(\omega)} = \left(1+\frac{1}{\varepsilon(\omega)}\right) \frac{\mu(\omega)}{\lambda \int_{\underline{\phi}}^{\overline{\phi}(\omega)} H_{\omega,\phi}(\tilde{\xi}(\omega,\phi)) dG_{\omega}(\phi) f(\omega)\omega},$$

where

$$\mu(\omega) = \int_{\omega}^{\overline{\omega}} \left( \lambda \left[ f(\omega) \int_{\underline{\phi}}^{\tilde{\phi}(\omega)} H_{\omega,\phi}(\tilde{\xi}(\omega,\phi) dG_{\omega}(\phi) + \Delta T(\omega) \left( \Delta Drop(\omega) + \Delta Crowd\text{-}in(\omega) \right) \right] - \Delta Drop(\omega) \right) d\omega.$$

and  $\lambda$  is implicitly defined by  $\mu(\underline{\omega}) = 0$ .

Note that Proposition 1 and Corollary 1 do not explicitly tell us something about the optimal fee schedule but only about the optimal labor supply distortion (wedge). How this, in turn, translates into the steepness of the preschool fee schedule depends on the pre-existing marginal tax rates:

**Corollary 2.** The optimal public preschool fee schedule is described by

$$F'_{pu}(y_{pu}(\omega)) = \tau_{pu}(\omega) - T'(y_{pu}(\omega)).$$

These theoretical derivations have shed light on the different forces at work and how they should be optimally traded-off. The interesting question is of course now what these results imply quantitatively. How steep should the optimal preschool fee schedule be? Or should it maybe even be decreasing? And how much better do optimal policies compare to current policies? We describe in detail our calibration to the U.S. economy in the next section, before we quantitatively explore optimal policies in Section 5.

# 4 Calibration

We calibrate our model in two steps. In the first step we use information on existing preschool programs and enrollment rates to setup an environment that represents current US preschool programs. In the second step we use experimental evidence from a variety of sources and calibrate our model to replicate them.

#### 4.1 Income Distribution & Labor Supply Elasticity

We apply a kernel density estimator with bandwidth 8000 to the household income data from the 2000 US Census public use micro sample.

For the disutility of effort, we assume the following functional form:  $v(l) = \frac{l^{1+\frac{1}{\varepsilon}}}{1+\frac{1}{\varepsilon}}$ . For the elasticity of labor supply we assume  $\varepsilon = 0.33$  (Chetty, Guren, Manoli, and Weber 2011). For U, we assume  $U(x) = \frac{x^{1-\gamma}}{1-\gamma}$  and set  $\gamma = 3$ . We chose this parameter to match the parental income gradient for preschool enrollment.

#### 4.2 Preschool Costs and Qualities

The cost of high quality preschool programs, such as those implemented in Georgia and Oklahoma, is approximately \$10,000 per pupil per year. We maintain the assumption that the cost of running lesser quality programs is proportional to this, for example a program that is half as effective would cost \$5,000 per pupil per year. Estimated costs of Head Start are \$8,000 per pupil per year, thus our benchmark model parameterizes the quality of Head Start as  $q_{hs} = 0.8$ . In our main optimal policy results we assume that  $q_{pu} = 1$ , thus the resource cost incurred by the planner is \$10,000 per pupil. In an extension we allow the planner to also vary quality, thus the resource cost is  $q_{pu} \times $10,000$  in that extension.

Our assumption is that attending a private preschool is equally as beneficial as attending a high-quality public preschool where  $q_{pu} = 1$ , and that the cost to parents of enrolling their child in such a program is the resource cost \$10,000 per year. We also assume that existing non-Head Start programs are of quality  $q_{pu} = 1$ , but of course the costs are subsidized. Following Kline and Walters (2015) we assume that for most public preschools half of the costs are paid through fees (paid by parents), and the other half is paid though public funding. However, in order for our benchmark model to generate realistic "crowding-out" by Head Start offers we need some progressiveness in preschool fees. For our model to generate the result that 30% of families in poverty who do not receive a Head Start offer still manage to send their children to preschool we need that only 13% of the cost is paid by parents when their income is below the poverty line.

#### 4.3 The Benefit of Preschool Attendance

Parameterizing the benefits of enrolling a child in a preschool program is extremely difficult. Estimates of the impact of preschool on future test scores and earnings range from massive to nil, and the lack of good experimental evidence makes it difficult to sort out which of these estimates is correct. The evidence we focus on to parameterize our model is based on the Head Start Impact Study, which includes an experiment that randomly assigns Head Start applicants to an experimental group that is offered a Head Start slot, and a control group that is not. Crucially, the alternative preschool arrangements of the control group are recorded, which allows us to interpret the distribution of effects on treated children within our model.

The effect of Head Start on children in the experimental group was an increase in their vocabulary scores by 0.1-0.3 standard deviations relative to the control group by the time they were in grade 1. However, as the work of Bitler, Domina and Hoynes (2014) has shown, students at the bottom of the distribution of pre-treatment skills benefited most. Our model can naturally reproduce these results because the probability of selecting into an alternative preschool when Head Start is not offered is increasing in parental income in our model. We

parameterize the baseline effect of attending preschool to be a 0.3 standard deviation increase in cognitive skills; however, the average effect of being selected into Head Start is substantially lower at just over 0.06 of a standard deviation for those just below the poverty threshold. This lower effect is not necessarily because preschool is less effective, but rather may be because a large fraction of parents at those income levels find alternative public (or possibly private) preschools for their children to attend.

#### 4.4 Benchmark Preschool Enrollment

A natural requirement of the benchmark model is that it be able to generate a distribution of preschool enrollment rates that replicates US aggregate data. We focus on three aggregate enrollment rates: the percentage of the appropriately aged children in any preschool, any public preschool (including head start), and the percentage of eligible children in head start. (The percentage of preschool aged children enrolled in a private program is redundant given overall enrollment and public program enrollment).

The 2010 October CPS supplement indicates that approximately 57.3% of children who are three or four years old were enrolled in a preschool program. Just over two-thirds of these children (36.7% of all children) are enrolled in a public program.<sup>2</sup> Some of the public preschool enrollment consists of Head Start enrollment. In 2010 there were 904,188 children enrolled in a head start program<sup>3</sup>, but this represents only just over two-fifths (40.7%) of eligible children.<sup>4</sup>

As we describe in more detail below, realistic heterogeneity in preferences for sending one's child to preschool ( $\xi$ ) is not enough to explain why only 40.7% of eligible children enroll in a head start program. The model must also include heterogeneity in access to a head start and other public preschool programs in order to account for the distribution of enrollment rates. We explicitly include heterogeneity in the availability of head start and/or other public programs by including random head start and public preschool offers to families in the benchmark model. However, families are free to turn these offers down if, for example, they have a strong preference for private preschool ( $\phi$ ). In our calibration 73.1% of eligible children receive head start offers, but many refuse so that 40.7% is the model head start enrollment rate among families below the poverty line. While preference heterogeneity causes some of the declined head start offers, some are also caused by alternative public preschool offers. To attain an overall public preschool enrollment rate of 36.7% we need an offer rate of 81.4% for public preschools (which are subsidized, but not free).

Lastly, the overall preschool enrollment rate is regulated by parental altruism ( $\theta$ ). To attain an overall share of 57.3% of children in some form of preschool we require  $\theta = 105$ . Altruism

 $<sup>^{2}</sup> These statistics are reported by Cascio and Schanzenbach, and independently verified using IPUMS data. \\^{3} http://eclkc.ohs.acf.hhs.gov/hslc/data/factsheets/2011-hs-program-factsheet.html$ 

<sup>&</sup>lt;sup>4</sup>Eligibility defined as children below the poverty line. http://www.census.gov/hhes/www/cpstables/ 032011/pov/new34\_100\_01.htm

by-and-large regulates the overall preschool enrollment rate because it regulates incentives to invest in private preschool whenever a public option is not offered. In order to attain 57.3% overall enrollment we require 20.6% enrolled in private preschools on top of the 36.7% enrolled in either form of public preschool (which the offer probabilities guarantee).

#### 4.5 Preference Heterogeneity

The model includes heterogeneity in two dimensions of parental preferences. The parameter  $\phi$  captures preferences for private versus public preschool, while the parameter  $\xi$  captures preferences for keeping children at home.

The public versus private preference is needed in order to capture the observation that some parents send their children to private preschools even when a high quality free program is available. As Cascio and Schanzenback (2013) show, the introduction of high quality public preschool in Georgia and Oklahoma reduced private preschool enrollment by approximately three percentage points from 20.6% to about 17.6%. Thus, despite public programs being free, many parents continue to enroll their child in private preschool.

In our model the public/private preference enters as  $\phi(\mathbf{1}_{ps=pr} - \mathbf{1}_{ps=pu})$ , where  $\phi \sim N(0, \sigma_{\phi})$ . We chose this specification as a simplified version of  $\phi_1 \mathbf{1}_{ps=pr} + \phi_2 \mathbf{1}_{ps=pu}$ . We originally found the general form more appealing, but found that we could not separately identify  $\phi_1$  and  $\phi_2$ . In the restricted case we are able to identify the single  $\phi$  parameter using the quasi-experimental evidence by Cascio and Schanzenback (2013), mentioned above. That is, we simulate a policy change in which we introduce a high quality universal public preschool program, along the lines of the Georgia and Oklahoma programs, and measure the resulting fall in private preschool enrollment. By setting  $\sigma_{\phi}$  sufficiently large, our model can replicate the reduction in private enrollment of only 3% in response to the program introduction.

Calibration of the preference for children at home follows a similar logic. The role of the preference for children at home is to explain why some parents do not enroll their child in preschool even when it is free. As Cascio and Schanzenback (2013) have shown, the introduction of high quality universal public preschool in Georgia and Oklahoma increase the overall enrollment rate by 15%; however, more than 20% of children still do not enroll. The preference for children at home enters the utility function as  $\xi \mathbf{1}_{ps=no}$ , where  $\xi \sim \exp(\lambda)$  is exponentially distributed with shape parameter (and mean)  $\lambda$ . By increasing  $\lambda$  we increase the measure of parents who would not enroll their child in preschool even if it were free and high quality because they very much prefer the child to be at home. The value of  $\lambda$  we choose is such that the increase in overall preschool enrollment is limited to 15% when we simulate the introduction of high quality universal preschool, as described in the previous paragraph.

### 5 Optimal Preschool Policies in the U.S.

#### 5.1 Benchmark Case

In the current version we focus on the policy objective of maximizing the number of children going to preschool. Figure 2 shows the optimal fee schedule as a function of family income. As can be seen, the fee starts at around zero and then concavely increases until parental income of roughly \$120,000 where it flattens out. Interestingly, individuals with family income above \$80,000 pay more than the actual costs and therefore also more than they would pay for a private preschool. The parents with income above \$50,000 who nevertheless send their children to public preschool must therefore have a preference for sending their children to a public school, i.e. a negative value of  $\psi$ .



Figure 2: Optimal Income-Contingent Fee Schedule

Figure 3 illustrates how the increasing fee schedule (or the decreasing subsidy schedule) translates into distortions on labor supply of the parents. The blue dashed-line shows the labor supply distortions coming from the income tax. The black dashed-dotted line illustrate the additional distortions – the marginal preschool fee – for parents, who send their children to public preschool. For low incomes they are even higher than the income tax itself. The highest value is reached around an income of \$30,000, where the marginal fee is 36%. The red bold line shows the effective marginal tax rate (i.e. the sum of the two) or more technically speaking the overall labor wedge for public preschool parents.

Figure 4 shows – as a function of family income – how many children go to private, public or no preschool in the optimal allocation. The black dashed line shows the share of children not going to any preschool. Interestingly, in the optimal allocation, not the poorest children are the most likely not to go to preschool but those with family income around \$30,000. The very poor parents are much easier to incentivize with subsidies because their marignal utility



Figure 3: Marginal Income Tax Rates, Marginal Preschool Fees and Effective Marginal Tax Rates

of consumption is higher, which is why the government targets them so heavily. For higher incomes in turn – even though subsidies still decrease with income – parents become sufficiently rich to pay for preschool and even send them to private preschool.



Figure 4: Children Outcomes in Optimal Allocation

Figure 5 shows how this relates to enrollment that is currently prevalent in the U.S. As can be seen enrollment increases at almost all income levels. How is that possible given that not more money is spent? The reason is that in the current situation preschool places are rationed. Thus, many poor parents get head start slots for free. Many of these parents would still send their children even it cost a little. Thus one can decrease subsidies for them (i.e. imposing small fees) without making them not send their children to preschool. These saved subsidies can then be used to push other children over the margin. Only for incomes around \$20,000 does enrollment decrease. This is because this is the cutoff value for head start eligibility in our calibration. Thus, in the current situation, these parents can still send their child to head start for free - given that they had the luck to get a slot. In the optimal allocation, however, they have to pay a fee for public preschool of \$1,600.

Overall enrollment increases from 58.3% to 69.6% and therefore by more than 11 percentage points. This is a large number given that taxes had not to be raised. This increase is achieved solely by subsidizing preschool more efficiently.



Figure 5: Children Outcomes in Optimal Allocation

#### 5.2 Robustness

#### 5.2.1 Different Elasticity

The costs of having a steep preschool fee schedule obviously increase in the elasticity of labor supply. We test how results change if we increase the elasticity to 0.5. In this preliminary version, we leave all other parameters constant – it is not a big problem for our results since we still match quite well the numbers to which we calibrated the model for  $\varepsilon = .33$ . In future versions, we will be more careful and recalibrate the whole model at this stage. Optimal policies are a bit less effective in this case. Overall enrollment only increases by 6.7 percentage points instead of 11.2 percentage points in the baseline scenario.

Figure 6 illustrates the optimal fee schedule for this case. It is less steep because the efficiency costs of having a steep schedule are higher now. The maximal marginal preschool rate is now at 31% at an income level of \$12,000. The overall policy conclusion, however, is not changed.

#### 5.2.2 Difference in Current Tax Calibration

The preexisting tax function is also important for our results as our theoretical analysis has shown. The higher marginal tax rates, the more distortive is an increasing preschool fee schedule. To quantitatively asses this channel, we assume the tax function to be more progressive.



Figure 6: Optimal Income-Contingent Fee Schedule for elasticity of .66

We therefore take a slightly different specification from Guner, Kaygusuz, and Ventura (2014): the one which includes all state taxes as well. Figure 7 compares the two different cases. As can be seen tax rates are up to 5 percentage points higher in this case.



Figure 7: Marginal Tax Rates with and without state taxes

Figure 8 illustrates the optimal fee schedule for this case. Comparing it to the optimal schedule illustrated in Figure 2, we can see that the optimal schedule is less steep. As a consequence, the power of optimal policies is a bit decreased. Enrollment is only increased by 9.8 percentage points instead of 11.2 percentage points.

# 6 Conclusion

We have taken a mechanism-design perspective on the policy debate about public preschool provision. We have developed a theory of how a public preschool fee schedule should vary with



Figure 8: Optimal Income-Contingent Fee Schedule for higher marginal tax rates

family income. We thereby did not impose any restrictions on the potential shape of such a schedule. Our formulas transparently highlight the (i) trade-off between crowd-in and crowdout on the one hand and on the (ii) trade-off between addressing trade-off (i) and labor supply incentives.

We have provided a thorough calibration to the U.S. and have used detailed information about existing preschool programs, enrollment patterns and quasi-experimental evidence. Our quantitative exploration revealed that preschool enrollment could be significantly increased by better targeting subsidies. Without increasing any taxes, the government could increase overall preschool enrollment by 10 percentage points. The necessary fee schedule would start around zero and steadily increase until a family income of roughly \$120,000. The additional implicit marginal tax rate implied is up to 24%.

In future work it would be interesting the model the private sector with more sophistication. Private preschool providers could for example respond to public providers by increasing quality. Further, we neglected the question of the optimal level of quality. To address such questions, more empirical evidence is needed about returns to the intensive margin in terms of money spend per child at preschool. Lastly, we only asked how the government should target a given level of public funds to children along the parental income distribution, but did not ask how much subsidies the government should pay overall. It would also be interesting to look to what extent higher subsidies to preschool pay for themselves through higher tax revenue in the future in the spirit of Findeisen and Sachs (2016), who look at college education subsidies.

# A Appendix

# A.1 Derivation of Fee Schedule with Mechanism-Design Approach To be added.

## References

- BAKER, M., J. GRUBER, AND K. MILLIGAN (2015): "Non-cognitive deficits and young adult outcomes: The long-run impacts of a universal child care program," Discussion paper, National Bureau of Economic Research.
- BARNETT, W. S., K. BROWN, AND R. SHORE (2004): "The Universal vs. Targeted Debate: Should the United States Have Preschool for All?," Discussion paper, National Institute of Early Education Research.
- BITLER, M. P., H. W. HOYNES, AND T. DOMINA (2014): "Experimental evidence on distributional effects of head start," Discussion paper, National Bureau of Economic Research.
- CASCIO, E. U., AND D. W. SCHANZENBACH (2013): "The Impacts of Expanding Access to High-Quality Preschool Education," Discussion paper, National Bureau of Economic Research.
- CHETTY, R., A. GUREN, D. MANOLI, AND A. WEBER (2011): "Are micro and macro labor supply elasticities consistent? A review of evidence on the intensive and extensive margins," *The American Economic Review*, 101(3), 471–475.
- CUNHA, F., J. J. HECKMAN, AND S. M. SCHENNACH (2010): "Estimating the technology of cognitive and noncognitive skill formation," *Econometrica*, 78(3), 883–931.
- CURRIE, J., AND D. ALMOND (2011): "Human capital development before age five," *Handbook* of labor economics, 4, 1315–1486.
- DIAMOND, P. (1998): "Optimal Income Taxation: An Example with a U-Shaped Pattern of Optimal Marginal Tax Rates," *The American Economic Review*, 88(1), 83–95.
- DUNCAN, G. J., AND K. MAGNUSON (2013): "Investing in preschool programs," *The Journal* of *Economic Perspectives*, 27(2), 109–132.
- FINDEISEN, S., AND D. SACHS (2015): "Education and Optimal Dynamic Taxation: The Role of Income-Contingent Student Loans," *Working Paper*.
  - (2016): "Optimal Financial Student Aid," Working Paper.

- FITZPATRICK, M. D. (2008): "Starting school at four: The effect of universal pre-kindergarten on children's academic achievement," *The BE Journal of Economic Analysis & Policy*, 8(1).
- FITZPATRICK, M. D. (2010): "Preschoolers Enrolled and Mothers at Work? The Effects of Universal Prekindergarten," Journal of Labor Economics, 28(1), 51–85.
- GUNER, N., R. KAYGUSUZ, AND G. VENTURA (2014): "Income taxation of US households: Facts and parametric estimates," *Review of Economic Dynamics*, 17(4), 559–581.
- HECKMAN, J. J. (2013): Giving kids a fair chance. Mit Press.
- HECKMAN, J. J., AND T. KAUTZ (2013): "Fostering and measuring skills: Interventions that improve character and cognition," Discussion paper, National Bureau of Economic Research.
- HECKMAN, J. J., S. H. MOON, R. PINTO, P. A. SAVELYEV, AND A. YAVITZ (2010a): "The rate of return to the HighScope Perry Preschool Program," *Journal of Public Economics*, 94(1), 114–128.
- (2010b): "The rate of return to the HighScope Perry Preschool Program," Journal of public Economics, 94(1), 114–128.
- HECKMAN, J. J., AND S. MOSSO (2014): "The Economics of Human Development and Social Mobility," Annual Review of Economics, 6.
- JACQUET, L., E. LEHMANN, AND B. VAN DER LINDEN (2013): "Optimal redistributive taxation with both extensive and intensive responses," *Journal of Economic Theory*, 148(5), 1770–1805.
- KANBUR, R., M. KEEN, AND M. TUOMALA (1994): "Optimal non-linear income taxation for the alleviation of income-poverty," *European Economic Review*, 38(8), 1613–1632.
- KANBUR, R., J. PIRTTILÄ, AND M. TUOMALA (2006): "NON-WELFARIST OPTIMAL TAX-ATION AND BEHAVIOURAL PUBLIC ECONOMICS," Journal of Economic Surveys, 20(5), 849–868.
- KLINE, P., AND C. WALTERS (2015): "Evaluating public programs with close substitutes: The case of Head start," Discussion paper, Mimeo.
- KOENIGER, W., AND J. PRAT (2015): "Human Capital and Optimal Redistribution," Working Paper.
- MIRRLEES, J. A. (1971): "An exploration in the theory of optimum income taxation," *The Review of Economic Studies*, pp. 175–208.

- PIKETTY, T. (1997): "La redistribution fiscale face au chomage," *Revue française d'économie*, 12(1), 157–201.
- ROCHET, J.-C., AND L. A. STOLE (2002): "Nonlinear pricing with random participation," *Review of economic Studies*, pp. 277–311.
- SAEZ, E. (2001): "Using Elasticities to Derive Optimal Income Tax Rates," Review of Economic Studies, 68(1), 205–229.
- STANTCHEVA, S. (2015): "Optimal taxation and human capital policies over the life cycle," Discussion paper, National Bureau of Economic Research.