

Optimal Redistribution Through Subsidies

Zi Yang Kang
University of Toronto

Mitchell Watt
Stanford University

November 16, 2024

21st Annual Berkeley/Columbia/Duke/MIT/Northwestern IO Theory Conference

Introduction

Governments often **redistribute** by **subsidizing private market consumption**.

Examples: food, childcare, transportation, pharmaceuticals, fuel, electricity

Subsidy programs in practice are often **nonlinear**: caps, co-pays, free provision.

Introduction

Governments often **redistribute** by **subsidizing private market consumption**.

Examples: food, childcare, transportation, pharmaceuticals, fuel, electricity

Subsidy programs in practice are often **nonlinear**: caps, co-pays, free provision.

This paper: we characterize **optimal nonlinear** consumption subsidies for redistribution.

Takeaways:

- ▶ Explicit characterization of **when** and **how** to intervene using consumption subsidies.
- ▶ Linear subsidies are **never optimal**.

Model

Model Overview

Consumers

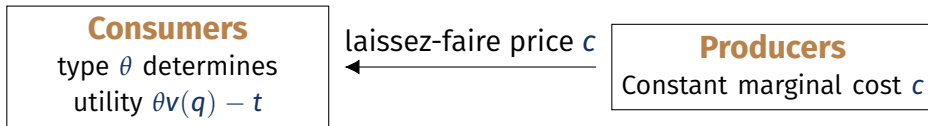
type θ determines

utility $\theta v(q) - t$

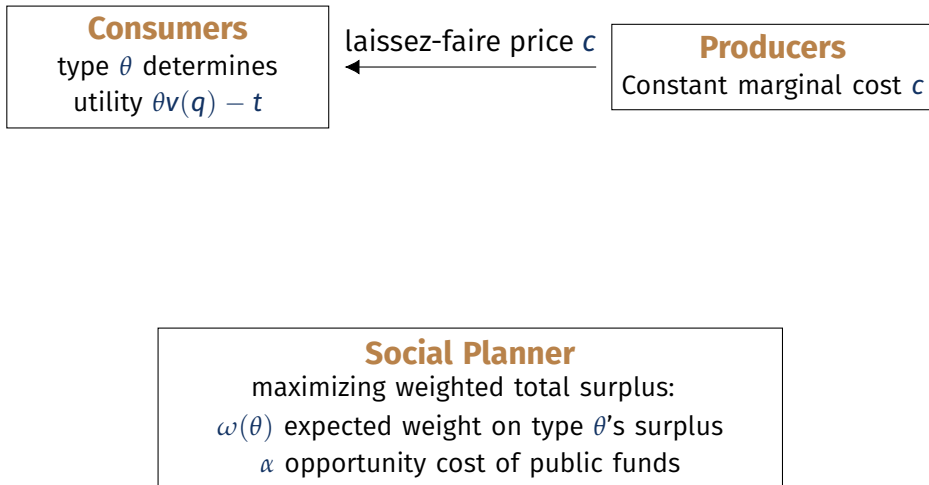
Producers

Constant marginal cost c

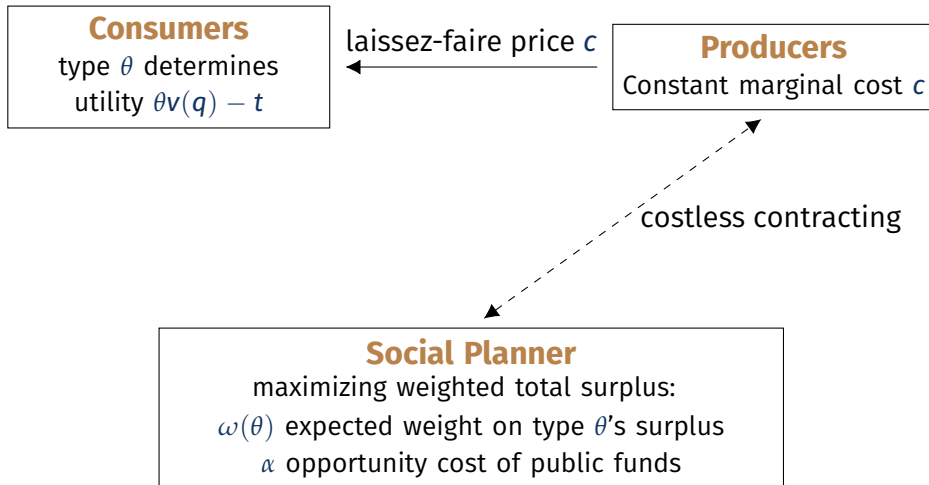
Model Overview



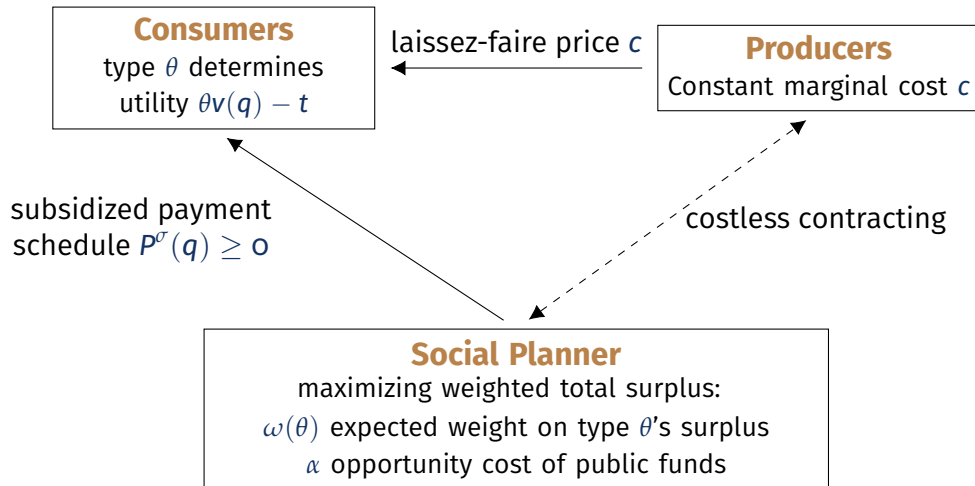
Model Overview



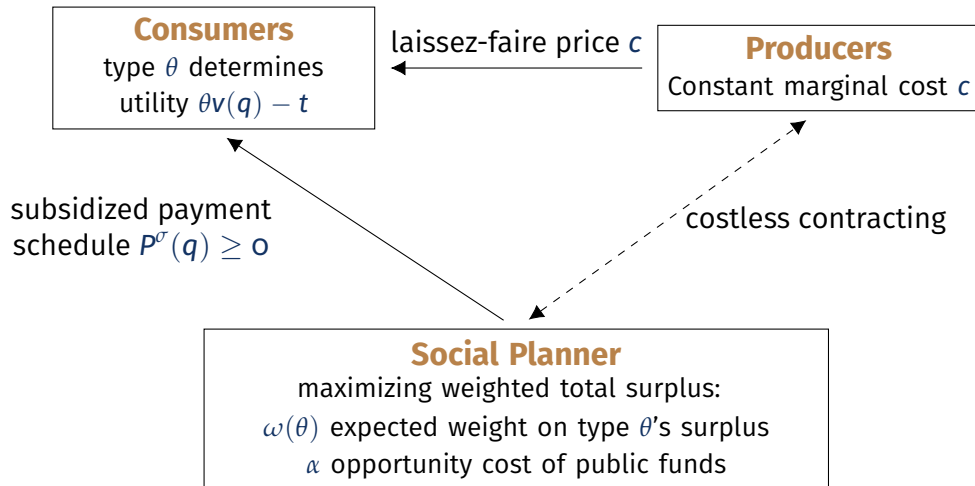
Model Overview



Model Overview



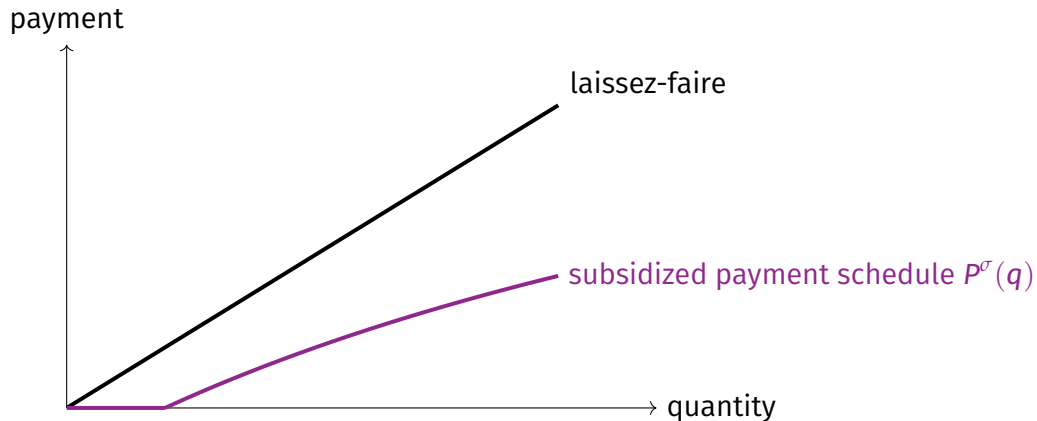
Model Overview



Consumers can purchase units from **both subsidized program and private market**.

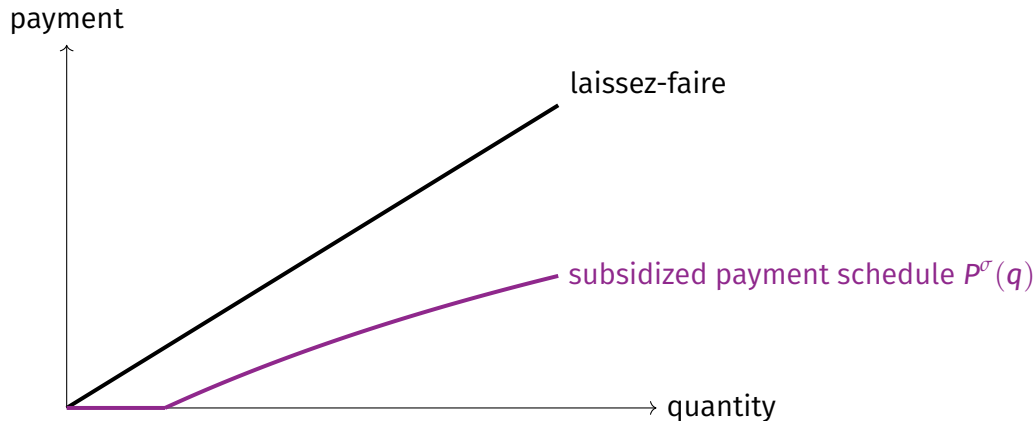
Private Market Access Constrains Implementable Price Schedules

private market access \iff **marginal price** $\leq c$



Private Market Access Constrains Implementable Price Schedules

private market access \iff **marginal price** $\leq c$ \iff **total subsidies** increase in q



When To Use Subsidies?

When Does The Social Planner Use Subsidies? A Sufficient Statistic

Theorem 1. The optimal subsidy mechanism (q^*, t^*) strictly improves on the laissez-faire outcome **if and only if** there exists a type $\hat{\theta}$ for which

$$\mathbf{E}_{\theta}[\omega(\theta) \mid \theta \geq \hat{\theta}] > \alpha.$$

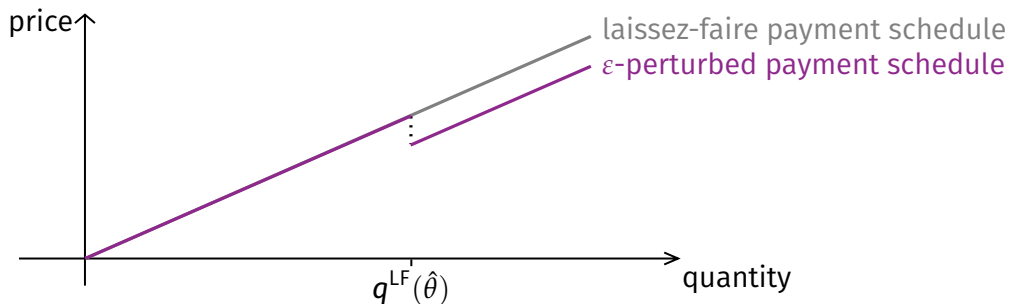
Interpretation: The social planner is willing to offer a **cash transfer** to all consumers with type exceeding $\hat{\theta}$.

When to Intervene: Proof by Picture

Suppose $\mathbf{E}_\theta[\omega(\theta)|\theta \geq \hat{\theta}] > \alpha$: we construct a subsidy schedule increasing weighted surplus.

When to Intervene: Proof by Picture

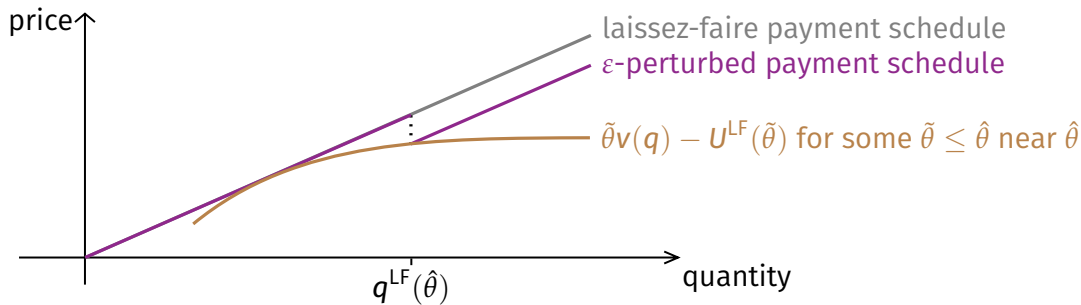
Suppose $\mathbf{E}_\theta[\omega(\theta)|\theta \geq \hat{\theta}] > \alpha$: we construct a subsidy schedule increasing weighted surplus.



ε-perturbation increases utility of types $\geq \hat{\theta}$, net benefit $\varepsilon \mathbf{E}_\theta[\omega(\theta) - \alpha|\theta \geq \hat{\theta}]$.

When to Intervene: Proof by Picture

Suppose $\mathbf{E}_\theta[\omega(\theta)|\theta \geq \hat{\theta}] > \alpha$: we construct a subsidy schedule increasing weighted surplus.



ε -perturbation increases utility of types $\geq \hat{\theta}$, net benefit $\varepsilon \mathbf{E}_\theta[\omega(\theta) - \alpha | \theta \geq \hat{\theta}]$.

But consumption is distorted for $O(\sqrt{\varepsilon})$ set of types near (but below) $\hat{\theta}$, at cost $\leq O(\sqrt{\varepsilon})\varepsilon$.

\leadsto Benefits $>$ costs for small enough ε . **Note: Argument relies on nonlinearity.**

when not to intervene

Interpreting the Sufficient Statistic

Social planner offers subsidies iff $\mathbf{E}_\theta[\omega(\theta) \mid \theta \geq \hat{\theta}] > \alpha$ for some $\hat{\theta}$.

Negative correlation: higher demand = lower need (e.g., food, education & normal goods)

Subsidies increase in $q \rightsquigarrow$ subsidies **more regressive** than cash transfers.

\rightsquigarrow For decreasing $\omega(\theta)$, social planner intervenes if and only if $\mathbf{E}_\theta[\omega] > \alpha$.

Interpreting the Sufficient Statistic

Social planner offers subsidies iff $\mathbf{E}_{\theta}[\omega(\theta) \mid \theta \geq \hat{\theta}] > \alpha$ for some $\hat{\theta}$.

Negative correlation: higher demand = lower need (e.g., food, education & normal goods)

Subsidies increase in $q \rightsquigarrow$ subsidies **more regressive** than cash transfers.

\rightsquigarrow For decreasing $\omega(\theta)$, social planner intervenes if and only if $\mathbf{E}_{\theta}[\omega] > \alpha$.

Positive correlation: higher demand = higher need (e.g., rice, buses & inferior goods)

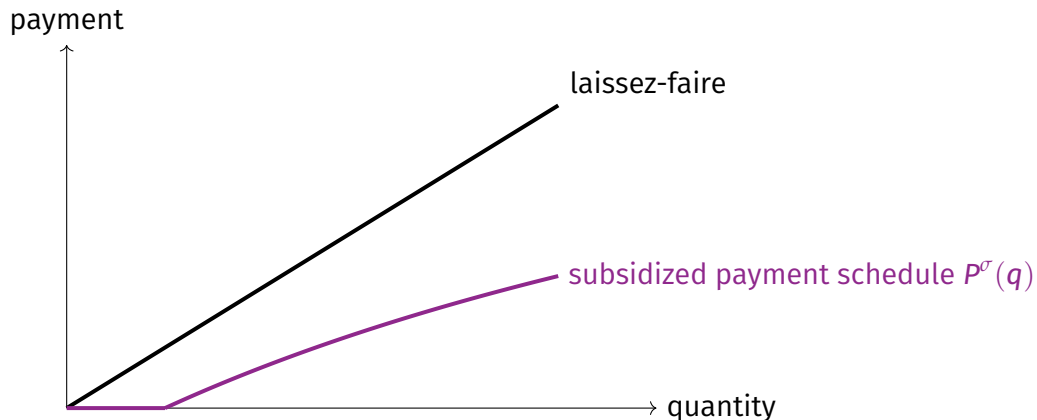
Subsidies increase in $q \rightsquigarrow$ subsidies **more redistributive** than cash transfers.

\rightsquigarrow For increasing $\omega(\theta)$, social planner intervenes if and only if $\max_{\theta} \omega(\theta) > \alpha$.

Optimal Subsidies

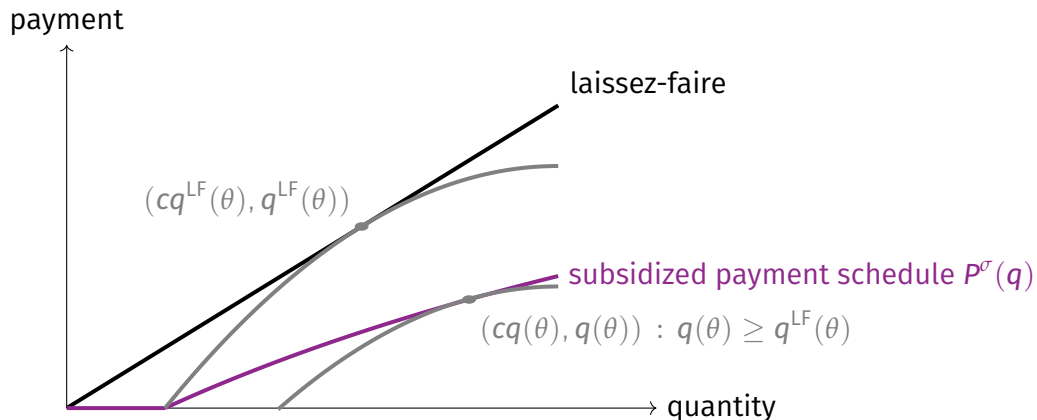
Private Market Access Constrains Implementable Allocation Rules

private market access \iff marginal price per unit $\leq c \iff$ subsidies increasing in q



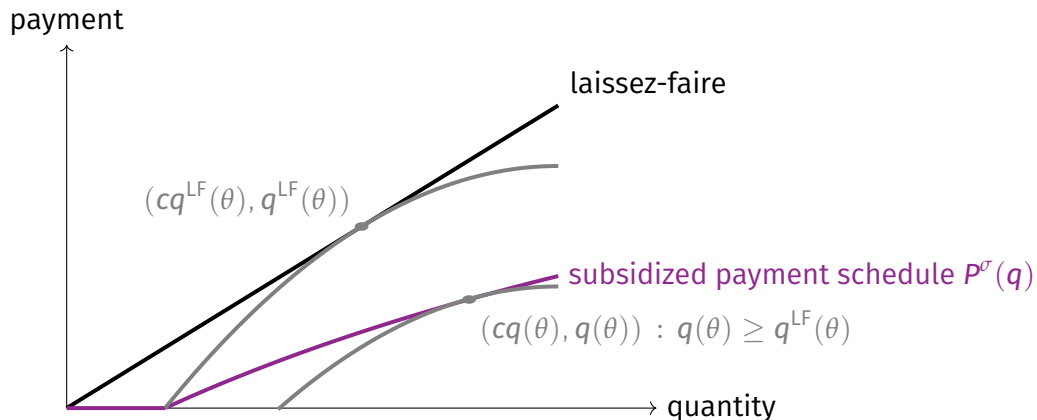
Private Market Access Constrains Implementable Allocation Rules

private market access \iff allocations exceed laissez-faire



Private Market Access Constrains Implementable Allocation Rules

⇒ mechanism design problem with a lower-bound constraint $q(\theta) \geq q^{LF}(\theta)$



Characterization of Optimal Subsidy Mechanism

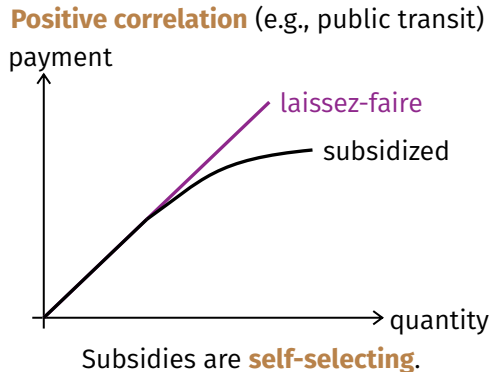
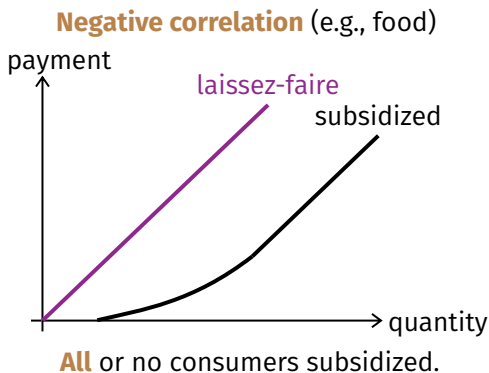
Theorem 2: We characterize the optimal subsidy allocation.

Key challenge: lower-bound constraint which can interact with the monotonicity constraint.
Requires a new “double” ironing operation \rightsquigarrow see paper for details.

Characterization of Optimal Subsidy Mechanism

Theorem 2: We characterize the optimal subsidy allocation.

Key challenge: lower-bound constraint which can interact with the monotonicity constraint.
Requires a new “double” ironing operation \rightsquigarrow see paper for details.



Discussion

Significant differences in marginal subsidy schedules observed in practice:

Larger subsidies for low q

- ▶ Food stamps (SNAP)
- ▶ Womens, Infants & Children (WIC) Program
- ▶ Housing Choice (Section 8) Vouchers
- ▶ Lifeline (Telecomm. Assistance) Program

Larger subsidies for high q

- ▶ Public transit fare capping
- ▶ Pharmaceutical subsidy programs
- ▶ Government-subsidized childcare places.
- ▶ Australian mental health subsidy program (“Better Access”).

program details

Private Market Restrictions

When Does the Planner Benefit from Private Market Restrictions?

In some markets (e.g., public housing), the social planner may be able to restrict subsidy recipients from topping up in private market \rightsquigarrow opt-in (or out) of subsidy program.

In **Kang and Watt (2024)**, we characterize optimal subsidy mechanism under such restrictions. These lead to different type-dependent outside option constraints:

$$\text{average price} \leq c \Leftrightarrow \text{majorization constraint on } q.$$

Key takeaway: Social planner benefits from restricting private market access when demand and need are negatively correlated, but **not** when they are positively correlated.

Conclusion

Concluding Remarks

Key contribution: characterization of the optimal nonlinear subsidy mechanism when consumers have access to private markets.

Secondary contribution: how to solve mechanism design problems with lower-bound constraints caused by type-dependent outside options.

Similar problems arise in other contexts, e.g., subsidy design for externalities, paternalistic motives.

In the industrial organization context, one application is **exclusive contracting**:

- ▶ Principal = profit-maximizing dominant firm, outside option = competitive fringe.
- ▶ Topping up = non-exclusive contracting, no topping up = exclusive contracting.

Fin

Thanks for the invitation!

Hire me: www.mitchellwatt.com

Related Literature

- ▶ **Public Finance.** Ramsey (1927), Diamond (1975), Mirrlees (1976, 1986), Atkinson and Stiglitz (1976), Doligalski, Dworczak, Krysta and Tokarski (2023), Nichols and Zeckhauser (1982), Blackorby and Donaldson (1988), Besley and Coate (1991), Blomquist and Christiansen (1998).
 ~ **This paper:** does not assume design of in-kind transfer, identifies optimal one.
- ▶ **Redistributive Mechanism Design.** Condorelli (2013), Dworczak, Kominers and Akbarpour (2021, 2022), Akbarpour, Budish, Dworczak and Akbarpour (2024), Pai and Strack (2024).
 ~ **This paper:** allows consumers to consume in private market (outside of planner's control).
- ▶ **Partial Mechanism Design.** Philippon and Skreta (2012), Tirole (2012), Fuchs and Skrzypacz (2015), Dworczak (2020), Loertscher and Muir (2022), Kang and Muir (2022), Kang (2023), Kang and Watt (2024).
 ~ **This paper:** focus on benchmark where planner is as efficient as private market, "topping up."
- ▶ **Methodological Tools in Mechanism Design.** Toikka (2011), Corrao et al. (2023), Yang and Zentefis (2024).
 ~ **This paper:** explicit characterization of solution with FOSD (topping up) constraint.

When Not To Subsidize: Negative Correlation

If demand and need are **negatively correlated**, with ω decreasing in θ , then consumption subsidies are **more regressive** than cash transfers.

When Not To Subsidize: Negative Correlation

If demand and need are **negatively correlated**, with ω decreasing in θ , then consumption subsidies are **more regressive** than cash transfers. To see this:

total subsidies increasing in $q \implies$ total subsidies increasing in θ

But then ω and total subsidy payments are negatively correlated so

$$\begin{aligned}\text{weighted increase in surplus} &= \mathbf{E}_{\theta}[\omega(\theta) \cdot (U(\theta) - U^{\text{LF}}(\theta))] \\ &\leq \mathbf{E}_{\theta}[\omega(\theta) \cdot \text{subsidy}(\theta)] \\ &< \mathbf{E}_{\theta}[\omega] \mathbf{E}_{\theta}[\text{subsidy}(\theta)] \\ &= \text{weighted value of equivalent cash transfer}\end{aligned}$$

When Not To Subsidize: Negative Correlation

If demand and need are **negatively correlated**, with ω decreasing in θ , then consumption subsidies are **more regressive** than cash transfers. To see this:

total subsidies increasing in $q \implies$ total subsidies increasing in θ

But then ω and total subsidy payments are negatively correlated so

$$\begin{aligned}\text{weighted increase in surplus} &= \mathbf{E}_{\theta}[\omega(\theta) \cdot (U(\theta) - U^{\text{LF}}(\theta))] \\ &\leq \mathbf{E}_{\theta}[\omega(\theta) \cdot \text{subsidy}(\theta)] \\ &< \mathbf{E}_{\theta}[\omega] \mathbf{E}_{\theta}[\text{subsidy}(\theta)] \\ &= \text{weighted value of equivalent cash transfer}\end{aligned}$$

With negative correlation, the social planner uses subsidies if and only if cash transfers are not available and $\mathbf{E}_{\theta}[\omega] > \alpha$.

Food Stamps (SNAP)

- ▶ **Overview:** U.S. program providing monthly food assistance to low-income individuals and families.
- ▶ **Initial Support:** Full subsidy up to a fixed dollar amount per month for eligible food items.
- ▶ **Free Endowment:** The subsidy starts as a full benefit and decreases after benefits are exhausted.
- ▶ **Low Consumption Focus:** Ensures a basic level of nutrition by covering initial consumption entirely.

[return](#)

Women, Infants, and Children (WIC)

- ▶ **Overview:** Nutritional assistance for low-income pregnant women, new mothers, and young children.
- ▶ **Initial Support:** Vouchers for essential foods like milk, eggs, baby formula.
- ▶ **Free Endowment:** Recipients get fully subsidized quantities of specific foods.
- ▶ **Low Consumption Focus:** Prioritizes providing a free minimum quantity of nutritious food to families.

[return](#)

Housing Choice Voucher Program (Section 8)

- ▶ **Overview:** Subsidized housing assistance for low-income renters in the U.S.
- ▶ **Initial Support:** Covers a large portion of rent (up to 70%) for qualifying households.
- ▶ **Free Endowment:** A significant rent portion is initially fully subsidized.
- ▶ **Low Consumption Focus:** Ensures low-income renters pay only a small portion of their rent.

[return](#)

Lifeline Program

- ▶ **Overview:** U.S. program offering discounted phone and internet services to low-income households.
- ▶ **Initial Support:** Monthly discounts on basic telecommunication services.
- ▶ **Free Endowment:** Full subsidy of basic services for the most disadvantaged users.
- ▶ **Low Consumption Focus:** Provides essential access to communication services with high initial subsidies.

[return](#)

National School Lunch Program (NSLP)

- ▶ **Overview:** Provides free or reduced-price school meals for low-income students.
- ▶ **Initial Support:** Fully subsidized meals for eligible students based on family income.
- ▶ **Free Endowment:** Full meal subsidies provided for families below certain income thresholds.
- ▶ **Low Consumption Focus:** Ensures children receive at least one nutritious meal per day at no or low cost.

[return](#)

Australian Better Access Mental Health Initiative

- ▶ **Overview:** Australian government program subsidizing mental health services.
- ▶ **Initial Subsidy:** Up to 10 Medicare-subsidized sessions per year.
- ▶ **Additional Support:**
 - * After initial sessions and doctor approval, become eligible for extra free/subsidized sessions.
 - * Increased subsidy ensures access for those needing more care.

[return](#)

Australia's Child Care Subsidy (CCS)

- ▶ **Overview:** Government subsidy for childcare costs based on income and activity levels.
- ▶ **Initial Subsidy:** Covers a percentage of childcare fees up to a set number of hours.
- ▶ **Additional Support:**
 - * Subsidy percentage **increases** as parents work, study, or volunteer more.
 - * More hours of work/study lead to higher subsidies for additional childcare hours.
 - * More children leads to higher subsidies per child.

[return](#)

Public Transit Fare Capping (New York)

- ▶ **Overview:** MTA system caps daily/weekly public transit fares.
- ▶ **Initial Fare:** Riders pay per trip up to a set limit.
- ▶ **Additional Support:**
 - * After reaching the cap, **additional rides are free** for the rest of the day/week.
 - * Frequent riders benefit from larger subsidies after hitting the cap.
- ▶ **Other Cities With Similar Programs:** SF Bay Area, Portland, London, Dublin, Toronto, Vancouver, Los Angeles, Singapore, Sydney, Brisbane, Melbourne, Perth, Auckland.

[return](#)

Pharmaceutical Subsidy Programs: Australia, Norway, Sweden, Denmark

- ▶ **Overview:** Government programs reducing out-of-pocket medication costs.
- ▶ **Australia (PBS):** Subsidizes prescription medicines; costs decrease after a yearly threshold (safety net) is reached.
- ▶ **Helsenorge (Norway):** Covers up to 90% of prescription costs after reaching an annual expenditure cap.
- ▶ **Sweden:** Once a patient reaches a yearly spending threshold, additional medications are free.
- ▶ **Denmark:** Progressive subsidy structure, with higher reimbursements as individual spending increases.

[return](#)

Cost-Sharing Reductions (CSRs) and Eligibility Limits

ACA Cost-Sharing Reductions (CSRs)

► What are CSRs?

- * Subsidies that lower out-of-pocket costs (e.g., co-pays, deductibles).
- * Available to individuals/families with incomes between 100% and 250% of the Federal Poverty Level (FPL).

► Eligibility Tied to Lower Insurance Plans

- * To qualify for CSRs, you *must* purchase a **Silver-level** plan on the ACA marketplace.
- * Other plan tiers (**Bronze, Gold, or Platinum**) **do not** offer CSRs, even if you're income-eligible.
- * Silver plans have a standard **70% actuarial value**, but CSRs raise it to up to **94%** for lower-income enrollees.

► Impact of Limiting to Silver Plans

- * Higher-income individuals may choose other plan levels, but lose CSR eligibility.
- * Lower-income enrollees are incentivized to choose Silver plans to reduce out-of-pocket costs.

German Health System: Prohibition of Topping Up

- ▶ **Public Health Insurance:** Citizens covered by statutory health insurance (SHI) cannot "top up" SHI with private insurance for services already covered.
- ▶ **Supplementary Insurance:** Private insurance can only be used for services not included in SHI (e.g., private rooms, certain dental services).
- ▶ **Comprehensive Coverage:** SHI already covers essential medical services, discouraging the need for topping up with private health plans.

[return](#)

Public Education: Prohibition of Private Tutoring in China & South Korea

- ▶ **Public Education:** Both China and South Korea provide universal public education for students, with restrictions on private supplementary tutoring.
- ▶ **Prohibition:** Private tutoring and after-school programs are heavily regulated or banned to prevent parents from "topping up" public education with private instruction.
- ▶ **Equal Access:** The aim is to reduce inequality in educational opportunities and prevent wealthier families from gaining an advantage through private education.

[return](#)

Public Housing

- ▶ **Public Housing Programs:** Residents in public housing receive heavily subsidized rent, often capped at a percentage of their income.
- ▶ **Prohibition:** Participants must choose between living in public housing or renting in the private market; they cannot "top up" their public housing subsidy to rent a private apartment.
- ▶ **Example Cities and Countries:**
 - * **Singapore:** The Housing & Development Board (HDB) provides subsidized flats, and participants cannot receive additional subsidies to live in private housing.
 - * **Vienna, Austria:** The city's extensive public housing program offers low-cost rental units, with no option to "top up" for private market rentals.
 - * **Hong Kong:** The Public Rental Housing (PRH) program offers heavily subsidized apartments, and recipients must choose between public housing and private market rentals.

[return](#)

Egypt's Tamween Food Subsidy Program

- ▶ **Overview:** The Tamween program is one of the largest food subsidy systems in the world, providing essential goods to over 60 million Egyptians, mostly from low-income households.
- ▶ **Targeted Subsidy:**
 - * **Bread:** Heavily subsidized at a fraction of market price (often less than 10% of the actual cost), making it affordable for the poor, who rely on it as a staple.
 - * **Other Essentials:** Subsidies also cover rice, sugar, and cooking oil, basic items central to the diets of low-income families.
- ▶ **Exclusion:**
 - * **Meat and Dairy:** These more expensive food items, consumed more frequently by wealthier households, are not subsidized. Consumers must pay market prices for these products.

[return](#)

Indonesian Fuel Subsidy Program: Pertamina

- ▶ **Overview:** Indonesia's fuel subsidy program supports transportation for low-income households.
- ▶ **Targeted Subsidy:** The program subsidizes low-octane fuel, which is primarily used by motorcycles, the preferred transport mode for poorer citizens.
- ▶ **Exclusion:** High-octane fuel, more commonly used by cars owned by wealthier households, is not subsidized.

[return](#)

CalFresh Restaurant Meals Program

- ▶ **Overview:** California's CalFresh program allows certain populations to use benefits for prepared meals.
- ▶ **Targeted Subsidy:** The program subsidizes meals, predominantly from fast food restaurants, providing affordable food options for homeless, elderly, and disabled individuals.
- ▶ **Exclusion:** Dine-in restaurants, typically frequented by wealthier individuals, are not included in the subsidy.

[return](#)

Public Dentistry Programs in Australia

- ▶ **Overview:** Australia's public dentistry programs provide dental care subsidies to low-income individuals.
- ▶ **Targeted Subsidy:** Prior to 2016, the program subsidized only amalgam fillings, a durable and cost-effective option used widely by lower-income patients.
- ▶ **Exclusion:** Composite (tooth-colored) fillings, which are more expensive and preferred by wealthier individuals, were not fully subsidized.
- ▶ **Post-2016:** amalgam fillings are being phased out due to mercury content.

[return](#)