Public Goods Provision in the Presence of Heterogeneous Green Preferences

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App State Workshop

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www.nytimes.com/2012/04/05/business/energy-environment/for-hybrid-and-electric-cars-to-pay-off-owners-must-wait.html?_r=1

Payoff for Efficient Cars Takes Years

Stephen Mally for The New York Times

Ed Moran and his new Toyota Prius. Like more and more Americans, Mr. Moran is looking to a fuel-efficient car to help soften the financial blow of ever higher gas prices.

By NICK BUNKLEY

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April 4, 2012
Payoff for Efficient Cars Takes Years
By NICK BUNKLEY
DETROIT — Ed Moran's new Toyota Prius was programmed by the dealer to make him feel good about his gas savings. A dashboard display compares the fuel consumption of the Prius and his 2001 Ford pickup truck.
"Every time I go to the store it will tell me how much money I saved," said Mr. Moran, a horticulturist in Ames, Iowa.
Like more and more Americans, Mr. Moran is looking to a fuel-efficient car to help soften the financial blow of ever higher gas prices.
Shoppers have more options than ever to fight back, including hybrids, plug-ins, electric vehicles and "eco" or "super fuel economy" packages.
But opting for models that promise better mileage through new technologies does not necessarily save money, according to data compiled for The New York Times by TrueCar.com, an automotive research Web site.
Except for two hybrids, the Prius and Lincoln MKZ, and the diesel-powered Volkswagen Jetta TDI, the added cost of the fuel-efficient technologies is so high that it would take the average driver many years — in some cases more than a decade — to save money over comparable new models with conventional internal-combustion engines.
That is true at today's pump prices, around $4, and also if gas were to climb to $5 a gallon, the data shows.
Gas would have to approach $8 a gallon before many of the cars could be expected to pay off in the six years an average person owns a car.
Analysts say the added cost of the new technologies is limiting the ability of fuel-efficient cars to gain broader appeal. Hybrid sales have surged more than 60 percent this year, but they still account for less than 3 percent of the total market. Plug-in cars represent a minuscule fraction of sales, with General Motors even halting production of the Chevrolet Volt in response to less demand than it expected.
"The point where a car can actually go after a mass-market audience is when the pricing starts making sense on paper," said Jesse Toprak, vice president for market intelligence at TrueCar. "If they want these technologies to be mainstream, pricing still needs to come down."
The Prius and Lincoln MKZ are likely to produce overall savings within two years versus similar-size gas-powered cars from the same brand, but other hybrids, despite ratings 8 to 12 miles per gallon better than conventional models, will cost more to buy and drive for at least five years.
The data assumes an average of 15,000 miles driven a year and a gas price of just under $4 a gallon.
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Households and Emissions

Consumers are significant polluters.

- 21% of GHG are residential (EPA).
- 19% of GHG are light duty vehicles and air transportation (EPA).

Household emissions reduction is necessary condition for any climate policy.

- Must understand factors driving conservation and adoption of more energy efficient goods.

Households and Emissions

Household emissions reduction is a well studied area.

1. Adoption of "green" technologies.

   Hausman (1979), Jaffe and Stavins (1994), Saphores, Nixon, Gounseitan, and Shapiro (2007), and Herberich, List, and Price (2011)).

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Key insight: Households have heterogeneous WTP for energy saving technologies and/or provision of environmental quality.

- Saphores et. al. (2007) find 35% of people WTP premium for energy efficient computer; 8% WTP premium over 10%.

Households, Emissions & Heterogeneity

What is driving heterogeneity in WTP to be "green"?

1. Behavioral issues.
   - Dual self, limited attention, bounded rationality.
   - Hausman (1979) and Allcott, Mullainathan, and Taubinksy (2012).

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2. Non-pecuniary channels
   - Change in MC of consumption.
   - Jacobsen, Kotchen, and Vandenbergh (2012) and Ferraro and Price (2011).

Households, Emissions & Heterogeneity

Our Contribution: We develop an alternative explaination of observed heterogeneity in WTP.

- Heterogeneity in benefits received from public goods provision.
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- Heterogeneity in benefits received from public goods provision.
  ex: Charness and Rabin (2002) preferences.
- All agents face identical increasing MC of provision curve.
  Accords well with engineering estimates.

Households, Emissions & Heterogeneity

Results:

1. Composition of public good provision is inefficient in private equilibrium
   Equimarginal principle is violated.

Households, Emissions & Heterogeneity

Results:

1. Composition of public good provision is inefficient in private equilibrium
   Equimarginal principle is violated.
2. Counterintuitive results w.r.t. alternative policy instruments.
   Technology standards always beat taxes.

Theoretical Model

Traditional Agents (Non-Greens)

$$\begin{aligned} U_i(c_i, X|\Theta) &= c_i + f_i(X) \\ & \qquad s.t. \;\; y_i = c_i + h(x_i) \\ \Rightarrow U_i(c_i, X|\Theta) &= y_i - h(x_i) + f_i(X) \end{aligned} \tag{1}$$

Cost of public goods provision is convex: $h'(\cdot) > 0, \quad h''(\cdot) > 0$

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Green Agents

$$\begin{aligned} U_i(c_i, X|\Theta) &= c_i + f_i(X) + s\Sigma_{j \neq i} f_j(X) \\ & \qquad s.t.\ \ y_i = c_i + h(x_i) \\ \Rightarrow U_i(c_i, X|\Theta) &= y_i - h(x_i) + \tilde{V} f(X)|_{\tilde{V}=1+s(N-1)} \end{aligned} \tag{2}$$

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$\alpha =$ percent "green" agents. $\Rightarrow \ X = \alpha N x_G^* + (1-\alpha) N x_U^*$

Theoretical Model

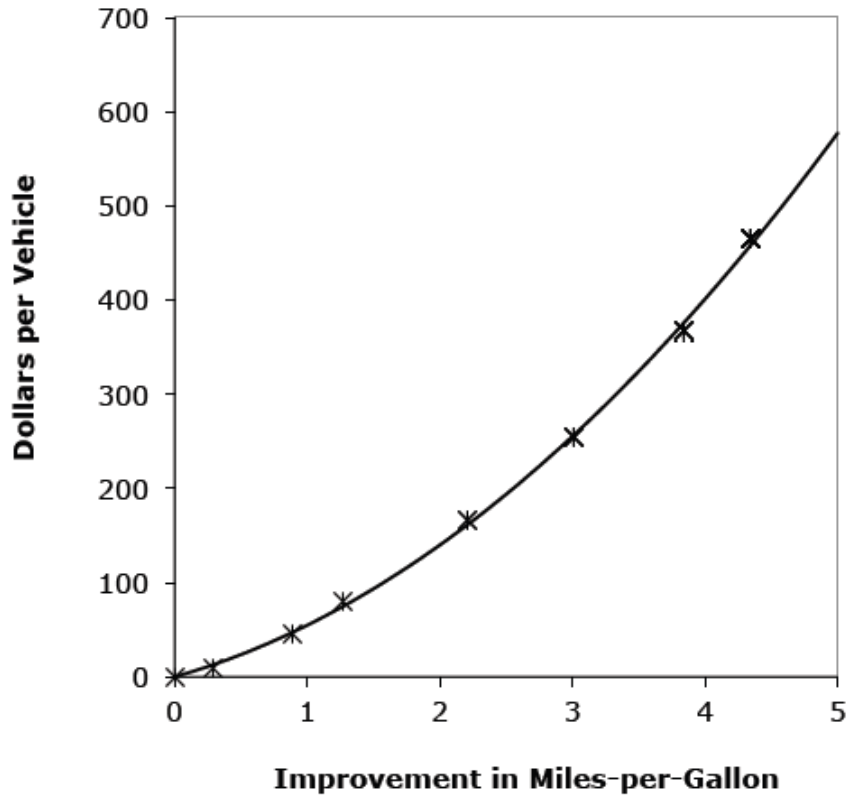


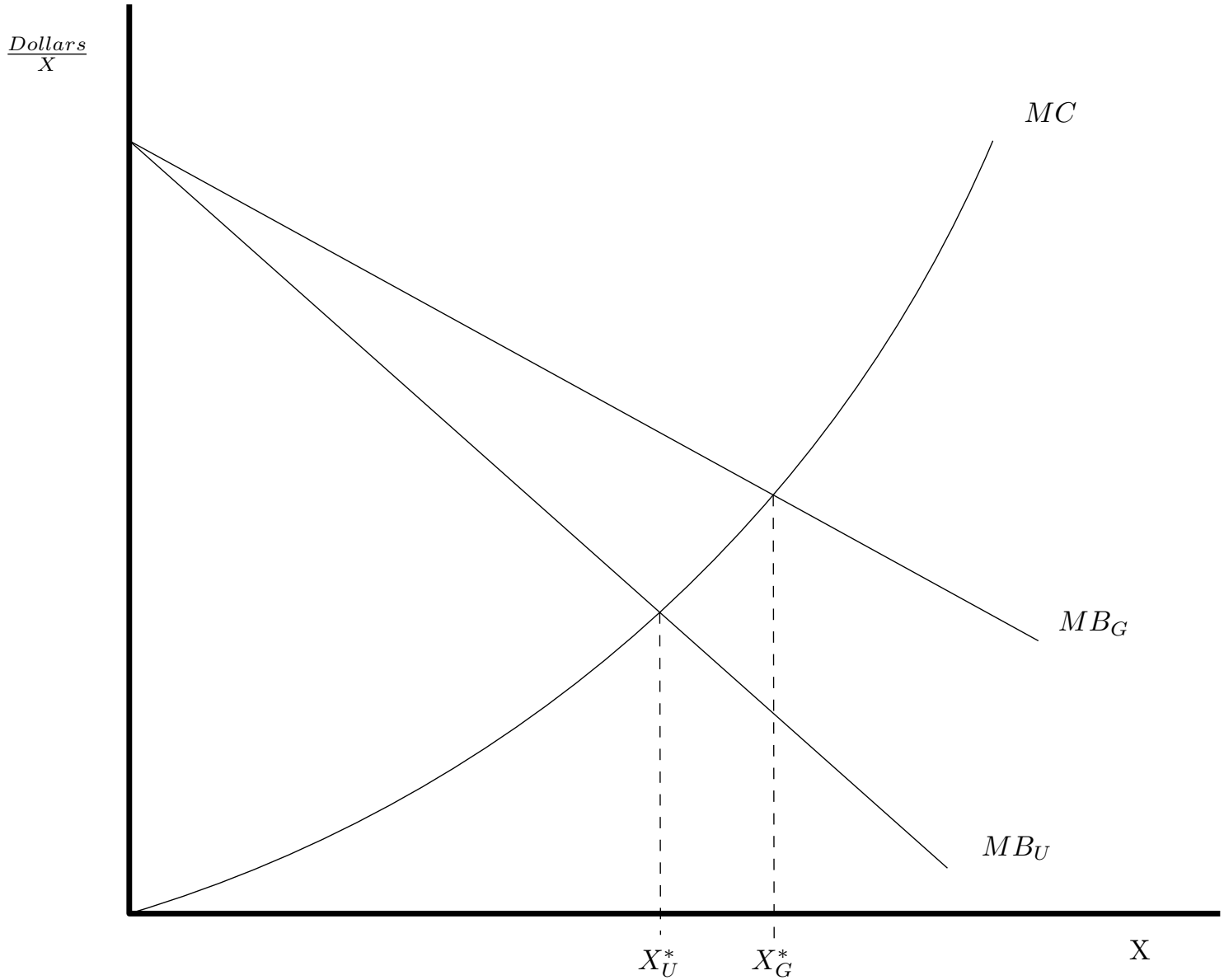
Figure: Engineering Cost of Improved Fuel Economy, Typical Compact (NRC 2002).

Theoretical Model

Result 1: Green agents always provide more of the public good than the non-green agents.

Result 2: For any given level of public good provision, it is cost minimizing to have all agents provide the same level of public good.

Theoretical Model

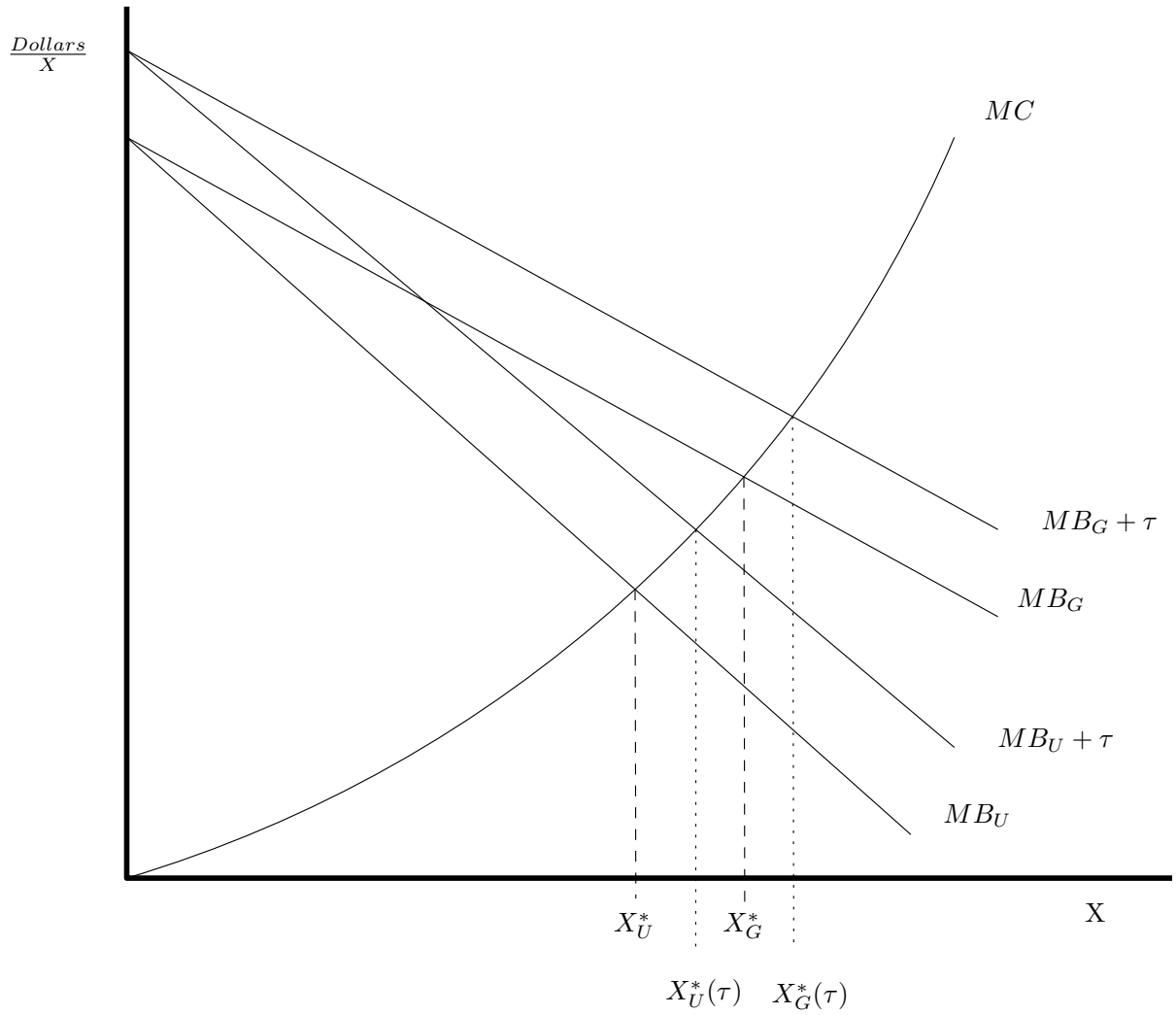


Theoretical Model

Result 3: For any level of public goods provision, a technology standard is always more efficient than a price instrument.

NOTE: At the consumer level, a quantity instrument acts as a price instrument.

Theoretical Model



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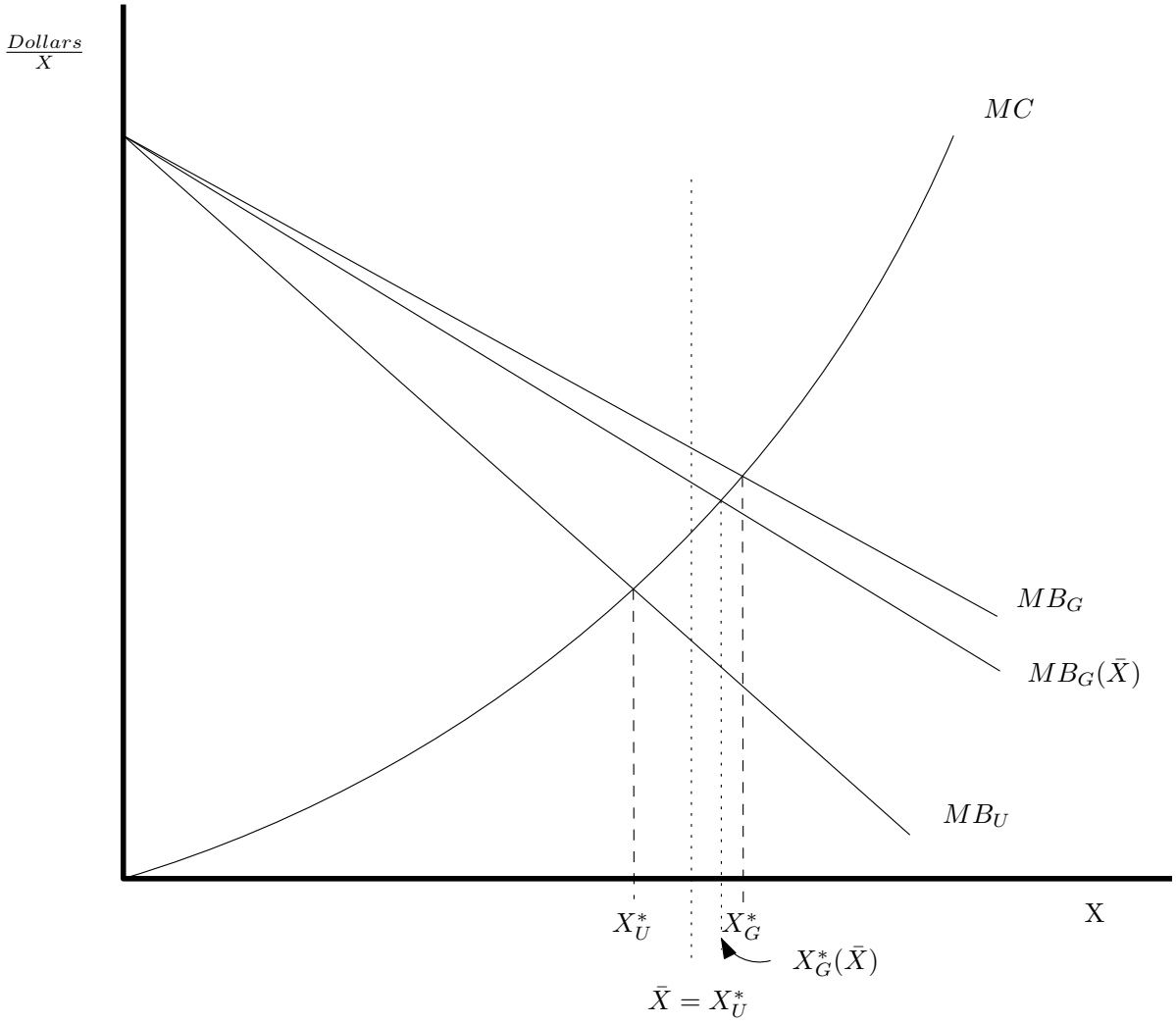
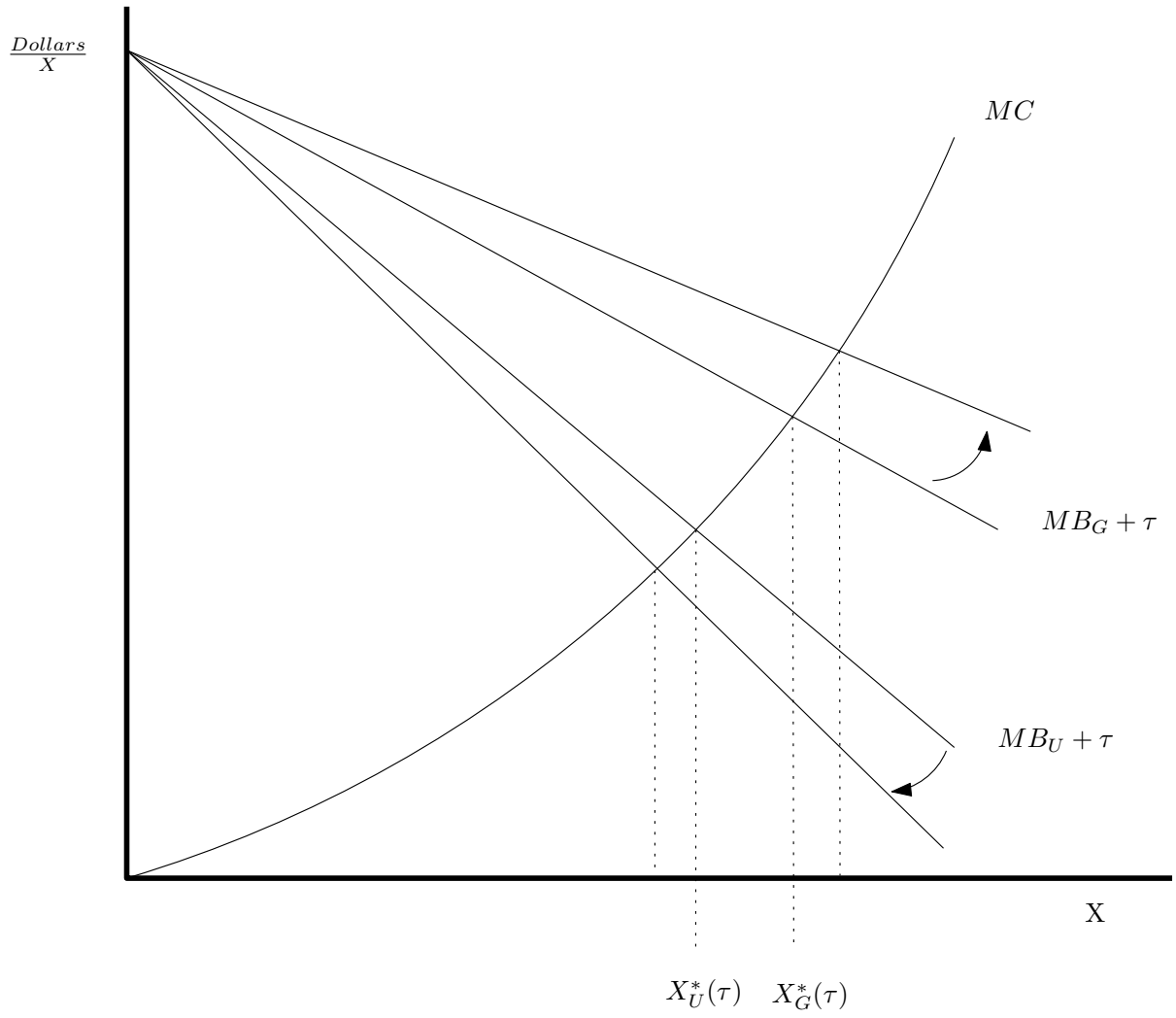


$$X_G^*(\bar{X}) - \bar{X} \; < \; X_G^*(\tau) - X_U^*(\tau)$$

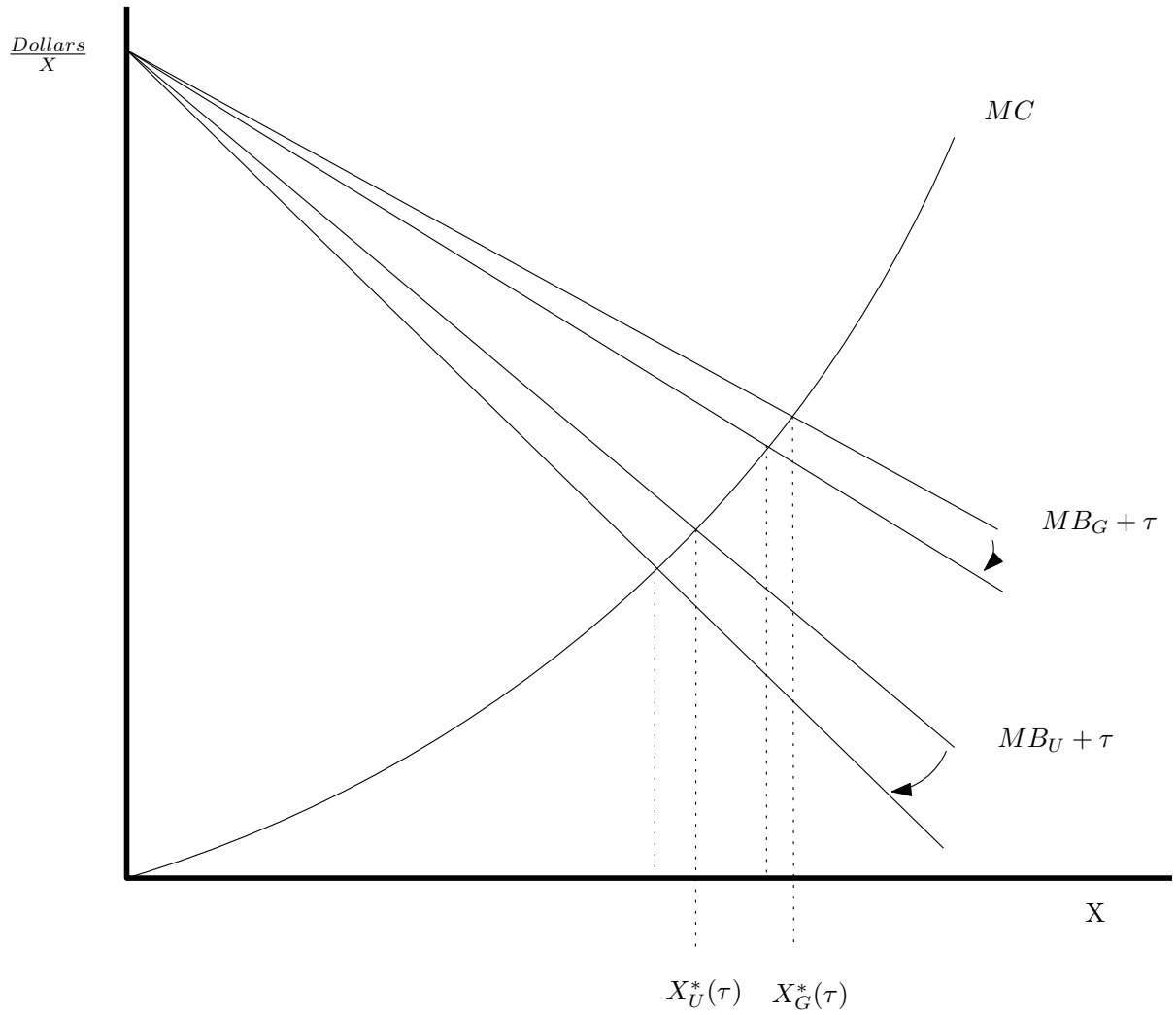
Results

Result 4: The provision of green agents in the case of price instruments, x_g^t, and the needed price instrument/subsidy, τ, to attain any public good level are both always decreasing in the percentage of green agents, α, while the former is increasingin strength of green preference, $\tilde{V}$.

Results: Strength of "Green" Preference



Results: Number "Greens"



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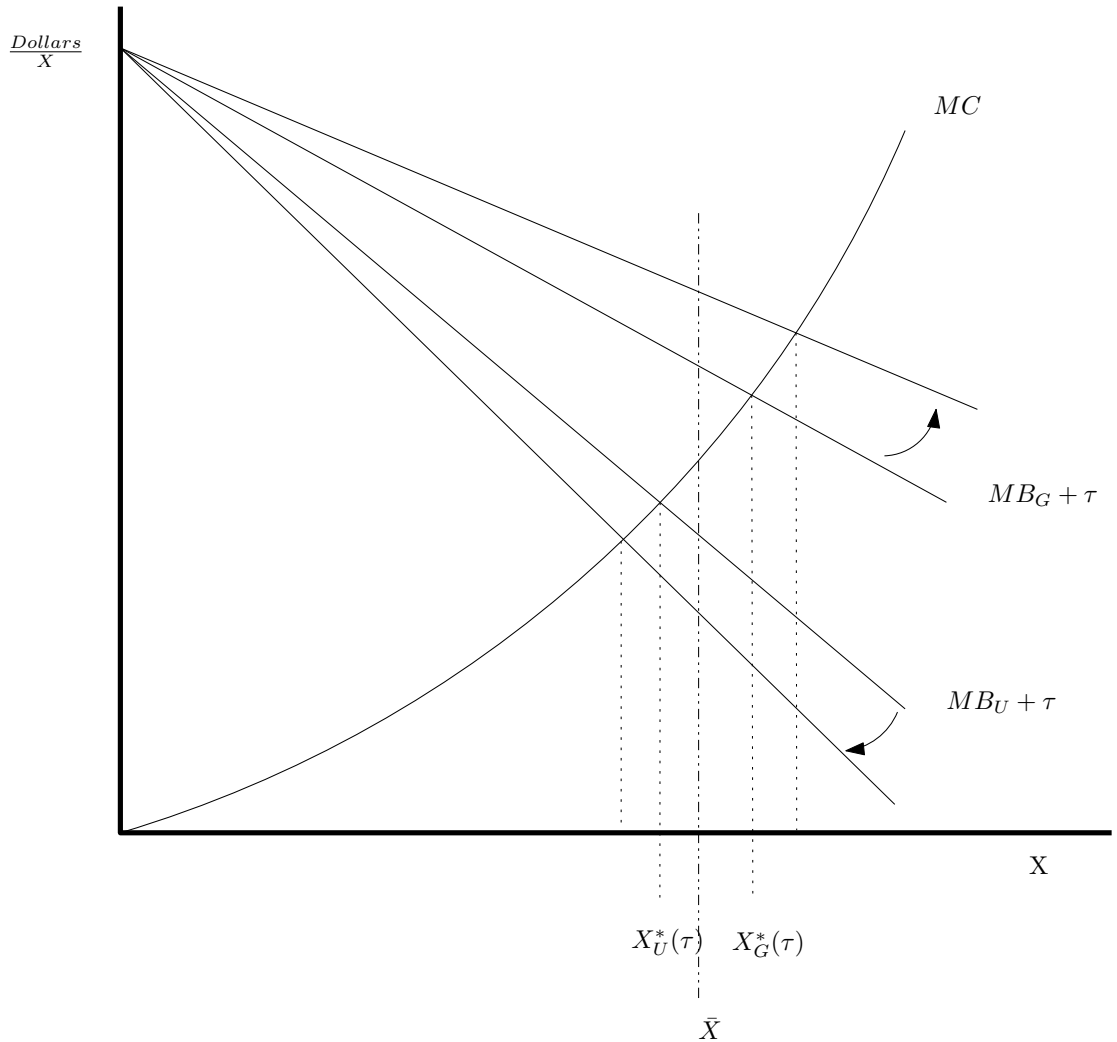
Result 6: For any level of regulated public goods provision $\tilde{X}$ such that $\frac{\tilde{X}}{N} \geq \hat{x_g}$, the difference in welfare between the two policies, Δ_{ts}, is always increasing in the strength of the green preference, $\tilde{V}$.

Theoretical Model



Discussions

Two examples:

1. Light bulbs: Incandescent, Halogen incandescent, CFL, LED and California's AB 1109 and Federal Law.
2. Autos: CAFE standards in effect subsidize all fuel efficient autos. Gas guzzler taxes act only on non-greens.

Conclusions

- Heterogeneity in WTP for "green" technologies exists but underlying source uncertain.
- If heterogenity is drivin by WTP for public good and adoption costs are convex then private equilibrium is inefficient.
- Costs of achieving any given level of public good provision (abatement) is lower under a standard in this case.
- Future work should relax assumption on multiple margins (e.g., car choice and miles driven) and cost curve.