Prosumers

Alberto Bisin* Hanzhe Zhang† Jinhua Zhao‡

April 25, 2025§

Abstract

Prosumers—individuals or entities that both produce and consume specific goods or services—are increasingly prevalent in various sectors, including energy, agriculture, and digital content creation. Despite their growing significance, a comprehensive theoretical framework analyzing markets with prosumption opportunities remains underdeveloped. This study investigates the market factors that influence the emergence and sustainability of prosumers. We explore equilibrium outcomes and welfare implications under conditions of both symmetric and asymmetric information about the quality of the good. Furthermore, we assess the impact of policy interventions—such as taxes, subsidies, and regulatory controls—on prosumption activities and market efficiency. We conduct our price-theoretic analysis under the usual supply-demand framework, but note significant differences; for example, the absence of the Harbenger deadweight loss triangle, recouped by prosumption activities.

Keywords: prosumers, farmers, solar energy

JEL: D11, D21, D5, Q11, Q42

*New York University, alberto.bisin@nyu.edu

†Michigan State University, hanzhe@msu.edu

‡Cornell University, jz638@cornell.edu

§We thank Heng Liu, Qingmin Liu, Michael Richter, and audience at various seminars for discussions and suggestions.

1 Introduction

Prosumers describe individuals or entities who act both as producers and consumers of specific goods or services.[1] Prosumers arise in many markets: homeowners who generate energy by solar panels for personal use and supply to the grid; farmers who raise crops and animals for personal use and market transactions; and contributors to online media and open-source software who also consume these contents. Prosumers have played an increasingly important role in many different markets, online and offline.

We provide a theoretical analysis of prosumption, especially the effects and welfare of the market with prosumption opportunities. We divide our analysis by whether the environment they engage in involves asymmetric information about the type of goods in consideration.

First, we analyze markets under symmetric information (or when asymmetric information is not a major concern). For example, homeowners who install solar panels generate electricity for personal use and can feed surplus energy back into the grid, effectively becoming both producers and consumers of energy (Parag and Sovacool, 2016; Gautier, Jacqmin, and Poudou, 2018; Inês et al., 2020; List, Pragidis, and Price, 2024; Pless, 2025). In addition, families decide their division of time and budget on household production, market labor supply, and leisure. Every household can be regarded as a prosumer in the overall economy (Becker, 1993).

Judged by their production and consumption decisions on one unit of indivisible good, agents are divided into four different types: (i) prosumers who produce and consume, (ii) sole producers who only produce but do not consume, (iii) sole consumers who only consume but do not produce, and (iv) hibernators who neither produce nor consume (see Figure 1a).

In the absence of transaction and information frictions, the four types of agents coexist: (i) agents who have a high valuation for the good and a low cost of production become prosumers; (ii) low-value low-cost agents produce only; (iii) high-value high-cost agents consume only; and (iv) low-value high-cost agents become hibernators.

With one unit of production and consumption, prosumers can be (i) *market prosumers* who produce one unit for sale on the market and consume one different unit from the market or (ii) *household prosumers* who produce and consume at home. In the absence of transaction costs, there is no difference between market prosumption and household prosumption, so no agent has a strict preference to become a household prosumer, i.e.,

[1] American futurist Alvin Toffler coined the term in 1980 (Toffler, 1980; Toffler and Toffler, 2006). Perera, Hewege, and Mai (2020) and Ertz, Cao, and Barragán Maravilla (2024) provide recent literature review.

an agent who produces one unit and consumes it.

With taxes—taxation on production, consumption, or transaction will yield equivalent outcomes in equilibrium, as in standard two-sided supply and demand in competitive markets—household prosumption strictly dominates market prosumption. In addition, the tax (i) discourages sole producers from supplying to the market, making some of them prosumers and others hibernators; and (ii) raises the effective price for sole consumers, making some of them prosumers and others hibernators. The market size shrinks drastically as a result (see Figure 6b).

Subsidies (e.g., on agricultural products) have the opposite effects: More prosumers arise, but socially inefficiently, as more low-efficiency (i.e., high-cost) producers enter the market. Individuals forgo personal consumption to supply to the market. We conduct similar welfare analyses for price ceiling and price floor.

We introduce *society/shadow* supply and demand curves that account for household prosumption activities and distinguish them from market supply and demand curves. This distinction allows us to formalize the idea that GDP does not capture household production (Kuznets, 1934; Becker, 1965; Bridgman et al., 2012).

Next, we examine markets with asymmetric information. For example, farmers who produce crops or raise livestock may leave some for their own consumption and may adjust production and consumption based on market conditions (Rustagi, 2024; Zhou et al., 2024). In the sharing economy, Airbnb hosts and Uber drivers use their houses and cars, respectively, for profitable activities as well as for their own consumption. On platforms like Etsy, eBay, and Amazon Marketplace, individuals both sell (produce) and buy (consume) goods and services. In the absence of ways to verify the quality of the product, we find that the market completely collapses, in the same spirit of Akerlof (1970): No agent is willing to supply a high-quality good to the market. As a result, individuals would only engage in household prosumption, and because they can verify the quality of their own products, they will produce a high-quality good.

A subsidy for market production is a costly and socially inefficient way to create a trading market. However, it will be a low-quality one. This is in spirit similar to asset buyback programs to resolve a financial crisis (Tirole, 2012).

There is scant economics literature, but other fields have considered prosumption in what economists consider as individual decision-making and partial equilibrium frameworks. The concept of prosumers was discussed in sociology. It is often concerned with consumers being (involuntarily) involved in the final delivery of services without receiving proper compensation (Ritzer, 2015). Recently, prosumers are increasingly being studied in renewable energy research because adopters of solar and wind energies not only con-

sume their own generated electricity but also sell surplus electricity back to the grids (Gautier, Jacqmin, and Poudou, 2018; Inês et al., 2020).

The rest of the paper is organized as follows. Section 2 introduces the benchmark model with unit-demand consumers and unit-supply producers. Section 3 analyzes equilibrium under different policies. Section 4 studies equilibrium under asymmetric information, and Section 5 concludes.

2 Equilibrium under symmetric information

We start our analysis by considering a market with agents who can produce and consume one unit of an indivisible good of homogeneous quality.

2.1 Model

Consider a unit mass of agents who can be producers and consumers. To start, suppose each agent can produce at most one unit and demand at most one unit. An agent is described by her cost $c \in [\underline{c}, \overline{c}]$ of producing the good and value $v \in [\underline{v}, \overline{v}]$ of consuming the good. In general, let $F(c, v)$ denote the joint cumulative distribution function; assume it is atomless. The marginal cost distribution of sellers and marginal value distribution of buyers are $F_s(c) = F(c, \overline{v})$ and $F_b(v) = F(\overline{c}, v)$, respectively. For illustration, let us first focus our attention on the case of uniform distribution: $F(c, v) = c \cdot v$, $F_s(c) \sim Unif[0, 1]$, $F_b \sim Unif[0, 1]$.

The timing of the model is as follows. First, each individual simultaneously decides her role in the society regarding production and consumption. In the framework of unit supply and unit demand, the following are possible choices of an individual: (i) market producer, who produces a unit for the market without consumption; (ii) market consumer, who demands a unit from the market without production; (iii) market prosumer, who supplies to the market and demands from the market; (iv) household prosumer, who produces and consumes a unit at home without sending it to the market; and (v) hibernator, who engages in no production or consumption. Given market price p and no other frictions, a type-(c, v) agent receives (i) $v - p$ from only consuming the good, (ii) $p - c$ from only producing the good, (iii) $v - c$ from doing both on the market, (iv) $v - c$ from doing both at home, and (v) 0 from being a hibernator.

Let $\rho_r(c, v)$ denote the probability of a type-(c, v) agent choosing role r. Without loss of generality, assume the probability is type-symmetric. Let $\rho(c, v) = (\rho_r(c, v))_r$ denote the strategy of a type-(c, v) agent. The overall population strategy is summarized by $\rho(\cdot)$.

Based on the aggregate demand and supply on the market, a uniform price p is determined and transactions occur. Goods are randomly allocated if there is an excess demand; the choice of allocation mechanism does not affect market outcome or welfare calculation since the good is homogeneous.

If there were excess demand or supply in the market, there would be individuals who do not receive a good on the market, or individuals who are left with a good. In case an individual does not receive a good and has not produced, she can produce a good to consume. If she supplied the good to the market and has not consumed a unit, she can consume the good herself. Note that these scenarios happen when the market does not clear. For many scenarios, market clears in equilibrium, so these scenarios do not happen and need not be considered.[2]

Let $\rho(c, v)$ describe the population strategy of type-(c, v) agents. We focus on the rational expectations equilibrium $(p^*, \rho^*(\cdot))$ in which (i) p^* is the equilibrium price given market demand and supply calculated based on $\rho^*(\cdot)$ and (ii) ρ^* is payoff-maximizing given market price p^*.

2.2 Benchmark equilibrium

First, consider the competitive equilibrium. Fix a market price p and suppose market clears so that there is no excess market supply or excess market demand (which will happen in equilibrium). An agent produces and consumes if

$$p - c > 0 \text{ and } v - p > 0 \Rightarrow c < p \text{ and } v > p. \qquad \text{(prosumer)}$$

Note that in the current benchmark setting, there is no strict difference between (i) being a market prosumer (supplying to the market and demanding from the market) and (ii) being a household prosumer (producing a unit and consuming it). Equilibrium price will not be affected by how individuals choose between these two options, since market will balance. An agent only produces and does not consume if

$$p - c > 0 \text{ and } v - p < 0 \Rightarrow c < p \text{ and } v < p. \qquad \text{(producer)}$$

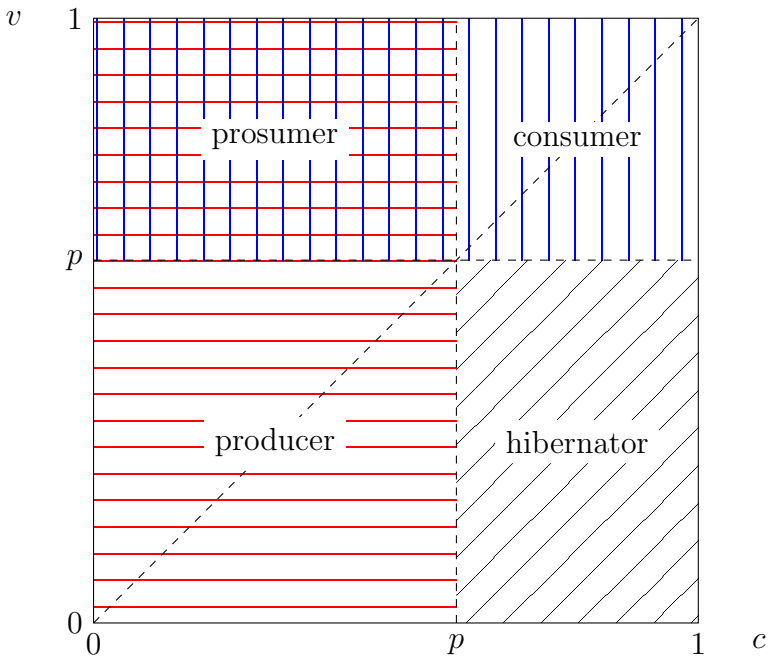
An agent does not produce and only consumes if

$$p - c < 0 \text{ and } v - p > 0 \Rightarrow c > p \text{ and } v > p. \qquad \text{(consumer)}$$

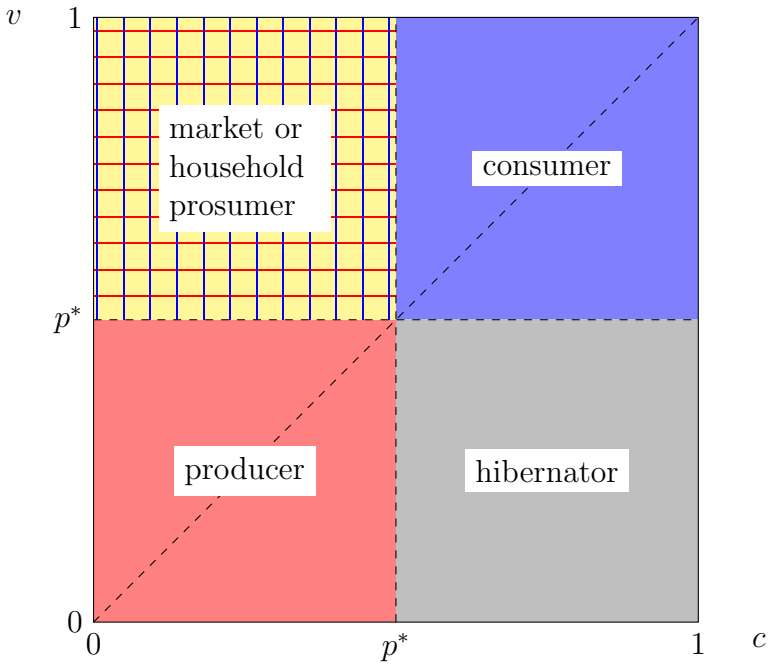
[2]We do not need to expand the choice possibility sets to accommodate these "second-period" choices. They are aftermaths of choosing to supply to the market and/or demand from the market.

Figure 1: Benchmark model

(a) Production and consumption decisions in the benchmark model



(b) Equilibrium in the benchmark model



An agent neither produces nor consumes if

$$p - c < 0 \text{ and } v - p < 0 \Rightarrow c > p \text{ and } v < p. \qquad \text{(hibernator)}$$

We illustrate these role choices in the two-dimensional c-v plane in Figure 1a.

Equilibrium price is determined by supply and demand. We can construct market supply and demand curves. For example, under uniform distributions, the market supply curve is $S(p) = p^2 + K$ and the market demand curve is $D(p) = (1-p)^2 + K$, where $K \in [0, p(1-p)]$ is the mass of agents who choose to be a market prosumer. Hence, the price that equates market quantity demanded and market quantity supplied is $D(p^*) = S(p^*) \Rightarrow p^* = 1/2$. Figure 1b illustrates the equilibrium choices and equilibrium price under uniform cost and value distributions. In general, the market supply function is $S(p) = F(p,p) + K(p)$, which is strictly increasing in p, and the market demand function is $D(p) = 1 - F_c(p) - F_v(p) + F(p,p) + K(p)$, which is strictly decreasing in p, where $K(p) \in [0, F_c(p) - F(p,p)]$ represents the mass of prosumers. The equilibrium price is determined by $S(p^*) = D(p^*)$, which is simplified to $F_c(p^*) = 1 - F_v(p^*)$; this equation represents equating market supply and demand when all activities happen in the market.

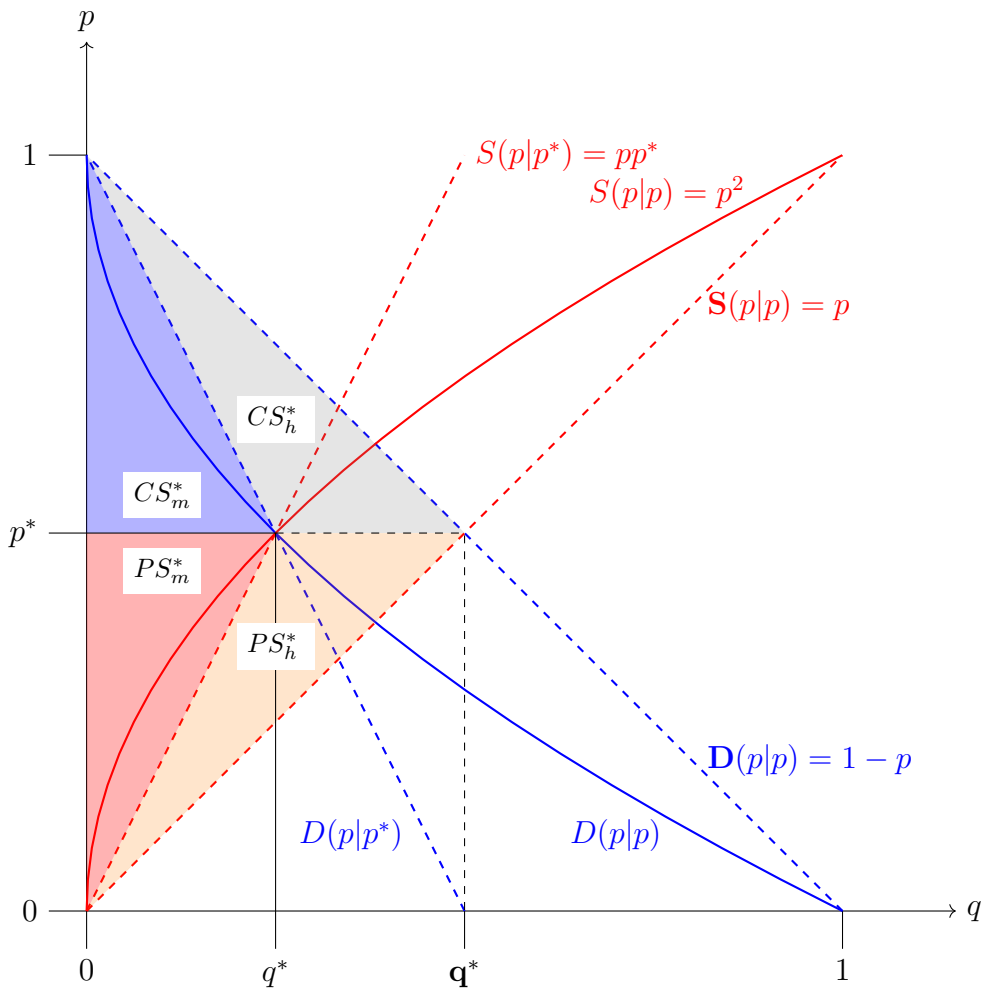
The mass of prosumers in equilibrium is $p^*(1-p^*)$. They could either participate in the market or prosume at home, and they are indifferent about it. Because market transactions are frictionless, we could assume that agents participate in the market whenever they are indifferent between the two options. If we assume so, there is no household prosumer. In this case, full market participation is a sign of market perfection. However, we could also assume that agents prosume at home whenever possible, because for any ϵ cost associated with market transactions (e.g., transportation cost, search cost), household prosumption is preferred. In our analysis below, all the different policies will break this tie between market and household prosumption.

2.3 Welfare analysis

We consider welfare next. We need to incorporate the welfare of prosumers in the setting. The total welfare can be calculated easily by assuming, without loss of generality, that all agents participate in the market. In this case, the total consumer surplus is $CS^* = \int_{p^*}^{1}(v - p^*)dF_v(v)$ and the total producer surplus is $PS^* = \int_0^{p^*}(p^* - c)dF_c(c)$. Under uniform distributions, these are $(v^2/2 - v/2)|_{1/2}^{1} = 1/8$ and $(c/2 - c^2/2)|_0^{1/2} = 1/8$, so the society aggregate surplus is $AS^* = 1/4$.

Figure 2 illustrates the welfare effects. Suppose every agent becomes a household prosumer when indifferent between a household prosumer and market prosumer. Solid

Figure 2: Supply and demand in the uniform benchmark setting



Notes. Suppose every agent becomes a household prosumer when indifferent between a household prosumer and market prosumer. Solid curves $S(p|p) = p^2$ and $D(p|p) = (1-p)^2$ represent market supply and demand curves, respectively, whereas dashed curves $\mathbf{S}(p|p) = p$ and $\mathbf{D}(p|p) = 1-p$ represent society/shadow supply and demand curves, respectively, by including the prosumers' own supply and demand. The price that equates $S(p|p)$ and $D(p|p)$, p^*, is equilibrium market price, and q^* represents equilibrium market quantity and $\mathbf{q}^*$ represents equilibrium society quantity. The blue shaded area labeled CS_m is the market consumer surplus, and the red shaded area labeled PS_m is the market producer surplus. When prosumers value their surplus based on shadow price p^*, the yellowish blue shaded area labeled CS_h is the household consumer surplus, and the yellowish red shaded area labeled PS_h is the household producer surplus. The combined yellowish shaded area labeled AS_h is the household aggregate surplus.

If we assume that agents randomly become a household prosumer or market prosumer whenever they are indifferent, $S(p|p)$ and $D(p|p)$ represent the lower bounds of the market supply and demand curves, and $\mathbf{S}(p|p)$ and $\mathbf{D}(p|p)$ represent the upper bounds. CS^*_m is the lower bound of market consumer surplus, and $CS^*_m + CS^*_h$ is the upper bound. PS^*_m is the lower bound of market producer surplus, and $PS^*_m + PS^*_h$ is the upper bound.

curves $S(p) = p^2$ and $D(p) = (1-p)^2$ represent market supply and demand curves, respectively, whereas dashed curves $\mathbf{S}(p) = p$ and $\mathbf{D}(p) = 1-p$ represent society/shadow supply and demand curves, respectively, by including the prosumers' own supply and demand. The price p^* that equates $S(p)$ and $D(p)$ is the equilibrium market price, and q^* represents equilibrium market quantity and $\mathbf{q}^*$ represents equilibrium society quantity.

The blue shaded area labeled CS_m^* is the market consumer surplus,

$$CS_m^* = \int_{p^*}^{1} (1-p^*)(v-p^*)dv = (1-p^*)(\frac{v^2}{2} - p^*v)|_{p^*}^{1} = 1/16.$$

The red shaded area labeled PS_m^* is the market producer surplus,

$$PS_m^* = \int_{0}^{p^*} p^*(p^*-c)dc = [p^*(p^*c - \frac{c^2}{2})]|_{0}^{p^*} = (p^*)^3/2 = 1/16.$$

When prosumers value their surplus based on shadow price p^*, the yellowish blue shaded area labeled CS_h^* is the household consumer surplus, and the yellowish red shaded area labeled PS_h^* is the household producer surplus. The combined yellowish shaded area labeled AS_h^* is the household aggregate surplus.

If we assume that agents randomly become a household prosumer or market prosumer whenever they are indifferent, $S(p)$ and $D(p)$ represent the lower bounds of the market supply and demand curves, and $\mathbf{S}(p)$ and $\mathbf{D}(p)$ represent the upper bounds. CS_m is the lower bound of market consumer surplus, and $CS_m + CS_h$ is the upper bound. PS_m is the lower bound of market producer surplus, and $PS_m + PS_h$ is the upper bound.

The difference between $S(p)$ and $\mathbf{S}(p)$ and that between $D(p)$ and $\mathbf{D}(p)$ illustrate the potential discrepancies between GDP accounting with and without consideration of household production and consumption (Kuznets, 1934).

3 Policy analysis under symmetric information

In this section, we consider the implications of several policies.

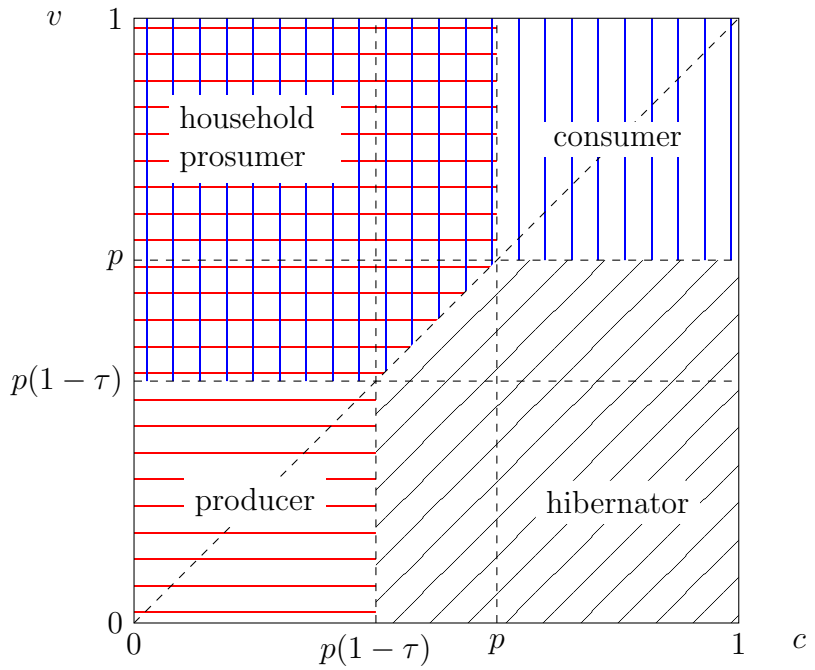
3.1 Taxes

3.1.1 Ad valorem market production tax

Suppose there is a tax rate $\tau \in (0,1)$ on goods supplied to the market, but not on goods produced and consumed at home. Because $\tau > 0$, any prosumer will strictly prefer being a household prosumer who produces and consumes at home (which generates payoff

Figure 3: Ad valorem market production tax

(a) Production and consumption decisions with ad valorem market production tax



(b) Equilibrium with ad valorem market production tax

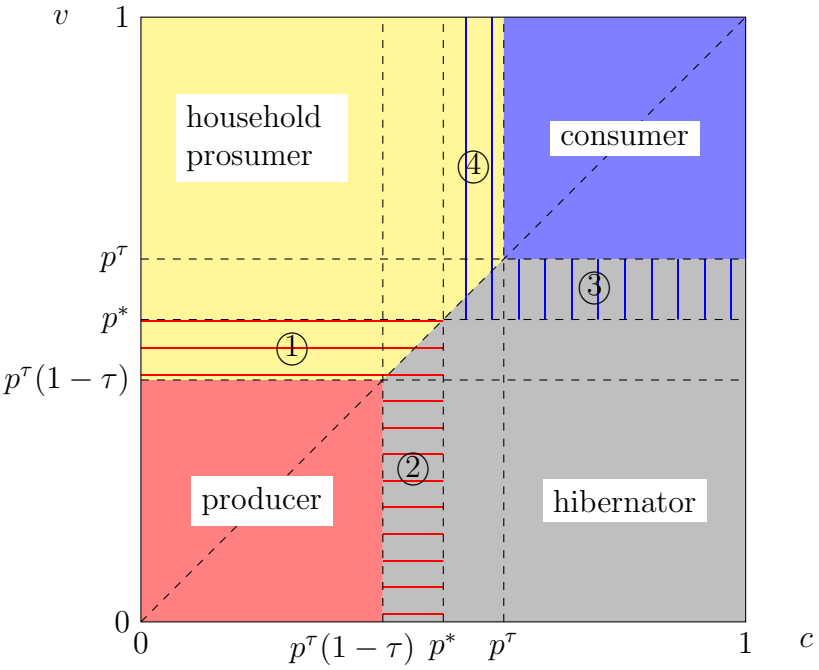


Figure 4: Supply and demand with ad valorem market production tax

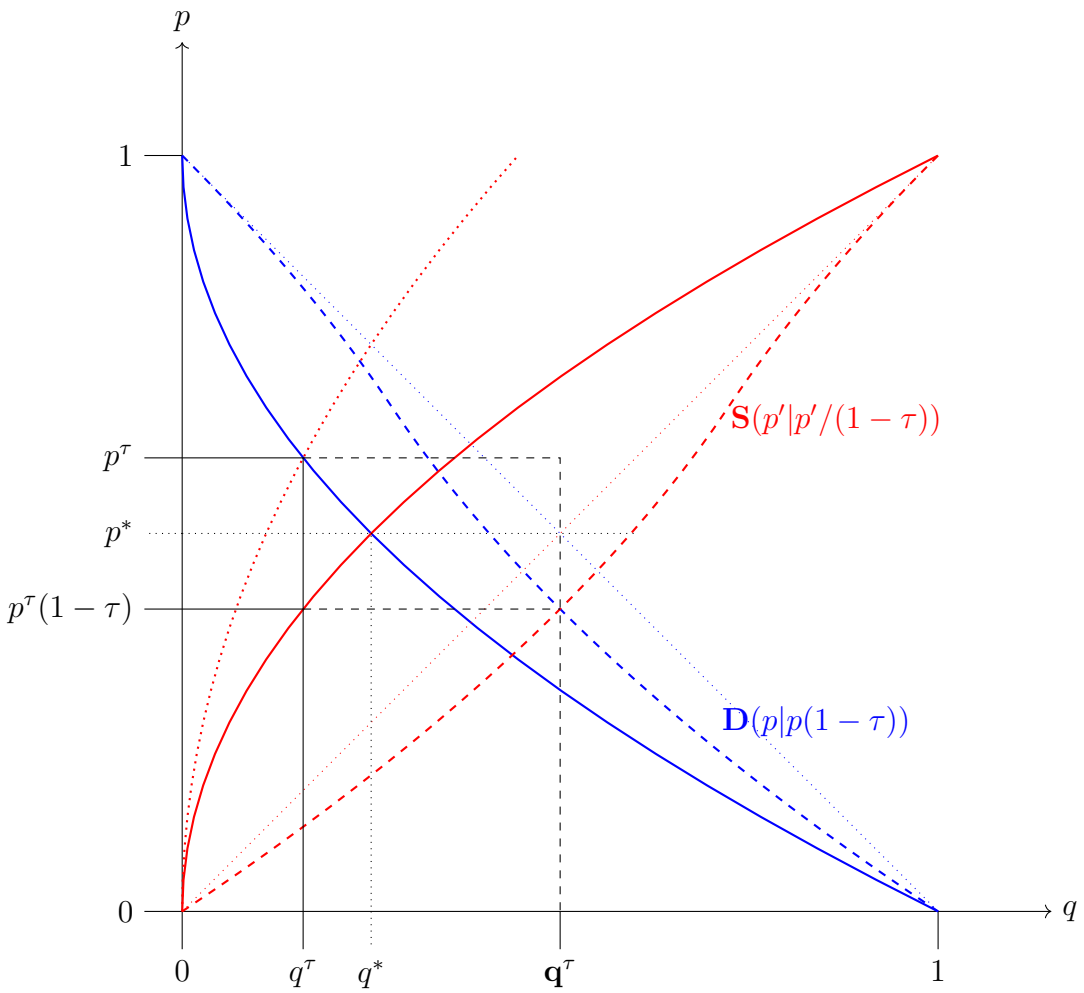
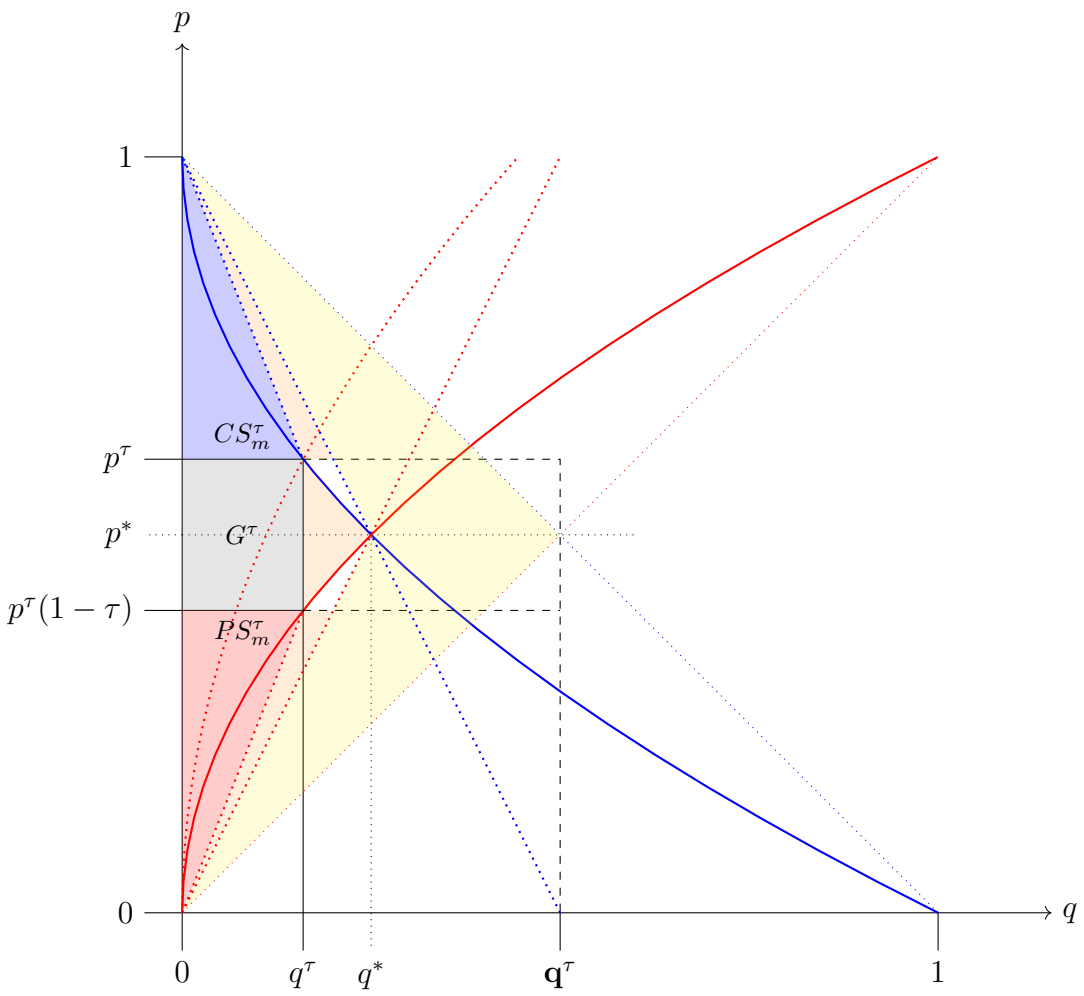


Figure 5: Welfare effects with ad valorem market production tax



Notes. CS_m^τ represents market consumer surplus, PS_m^τ represents market producer surplus, and G^τ represents government tax. The yellow area represents household prosumer surplus for prosumers of $v > p^*$ and $c < p^*$. The orange area is the household prosumer surplus for "new" household prosumers in the tax setting. The white area is the deadweight loss.

$v-c$) to being a market prosumer who supplies to and consumes from the market (which generates payoff $v-p+p(1-\tau)-c = v-c-p\tau$. Given market price p, an agent chooses to be a prosumer if

$$\begin{aligned} \text{prosuming is better than hibernating}: &\quad v-c>0, \\ \text{prosuming is better than producing}: &\quad v-c>p(1-\tau)-c \Rightarrow v>p(1-\tau); \text{ and} \\ \text{prosuming is better than consuming}: &\quad v-c>v-p \Rightarrow c<p. \end{aligned}$$

Figure 3a illustrates the conditions for prosumption: $v-c>0$, $v>p'$, and $c<p$, where $p' \equiv p(1-\tau)$ is the effective price faced by market producers. A combination of low value ($v<p'$) and low cost ($c<p'$) makes an agent a sole producer, and a combination of high value ($v>p$) and high cost ($c>p$) makes an agent a sole consumer.

Under uniform distributions of cost and value, the market supply curve is $S^\tau(p') = (p')^2 \equiv (p\cdot(1-\tau))^2$ and the market demand curve is $D^\tau(p) = (1-p)^2$. The market clears when $S^\tau(p\cdot(1-\tau)) = D^\tau(p)$, namely, $(p(1-\tau))^2 = (1-p)^2$. Hence, equilibrium market price is $p^\tau = 1/(2-\tau)$, and the effective market price faced by producers is $p^\tau\cdot(1-\tau) = (1-\tau)/(2-\tau)$.

The society supply curve when producers face effective price p' is

$$\mathbf{S}^\tau(p') = \begin{cases} p' + \left[(1-p') + \left(1-\frac{p'}{1-\tau}\right)\right]\frac{p'}{1-\tau}\tau/2 & \text{if } p'<1-\tau \\ p' + (1-p')^2/2 & \text{if } p'\geq 1-\tau \end{cases}$$

The society supply curve under market price p is

$$\mathbf{S}^\tau(p) = p(1-\tau) + [(1-p)+(1-p(1-\tau))][(1-p)-(1-p(1-\tau))]/2.$$

The society demand curve when consumers face price p is

$$\mathbf{D}^\tau(p) = \begin{cases} 1-p+[p+p(1-\tau)][p-p(1-\tau)]/2 & \text{if } p<1, \\ [1+p(1-\tau)][1-p(1-\tau)]/2 & \text{if } p\in[1,1/(1-\tau)]. \end{cases}$$

Alternatively, we have

$$\mathbf{D}^\tau(p') = \begin{cases} 1-p'/(1-\tau)+[p'/(1-\tau)+p'][[p'/(1-\tau)-p']/2 & \text{if } p'<1-\tau, \\ (1+p')(1-p')/2 & \text{if } p'\geq 1-\tau. \end{cases}$$

Household aggregate surplus can be expressed as

$$AS_h^\tau = \int_0^{p^\tau(1-\tau)} \int_{p^\tau(1-\tau)}^1 (v-c)\,dv\,dc + \int_{p^\tau(1-\tau)}^{p^\tau} \int_c^1 (v-c)\,dv\,dc.$$

Market consumer surplus is

$$CS_m^\tau = \int_{p^\tau}^1 \int_{p^\tau}^1 [v-p^\tau] dv dc = \frac{4}{125}.$$

Market producer surplus is

$$PS_m^\tau = \int_0^{p^\tau(1-\tau)} \int_0^{p^\tau(1-\tau)} [p^\tau(1-\tau)-c] dc dv = \frac{4}{125}.$$

The additional household surplus is regions ① and ④:

$$\begin{aligned} AS_{①} &= \int_{p^\tau(1-\tau)}^{p^*} \int_0^v (v-c) dc dv \\ &= \int_{p^\tau(1-\tau)}^{p^*} \frac{v^2}{2} dv = \int_{p^\tau(1-\tau)}^{p^*} \left[v^2 - p^\tau(1-\tau) + p^\tau(1-\tau) - \frac{v^2}{2} \right] dv \\ &= \left. \frac{v^3}{6} \right|_{p^\tau(1-\tau)}^{p^*} = \frac{61}{6000}. \end{aligned}$$

Region ④ is

$$\begin{aligned} AS_{④} &= \int_{p^*}^{p^\tau} \int_c^1 (v-c) dv dc \\ &= \int_{p^*}^{p^\tau} \frac{(1-c)^2}{2} dc = \frac{61}{6000}. \end{aligned}$$

Tax G is

$$q^\tau(\tau) * (p^\tau) = \frac{4}{125}.$$

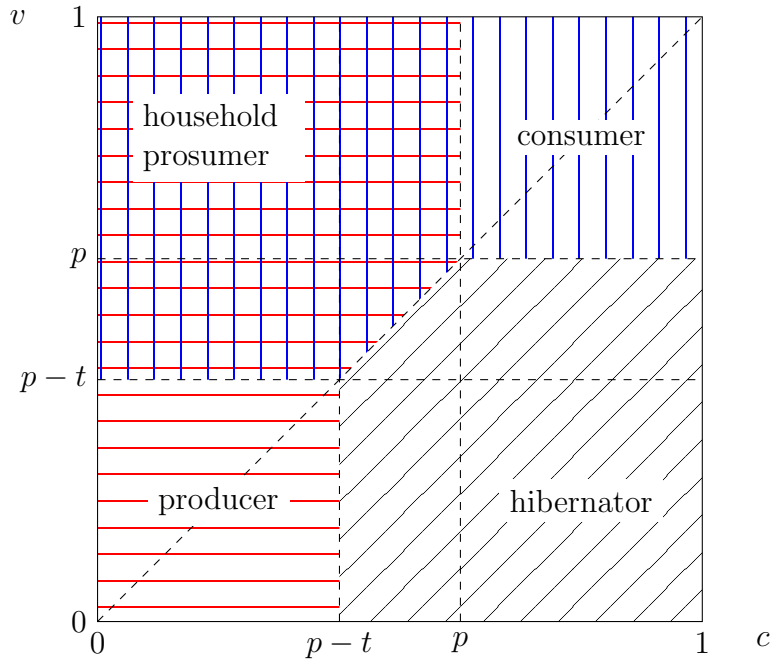
3.1.2 Flat market production tax

Suppose there is a flat tax $t > 0$ on goods supplied to the market, but not on goods produced and consumed at home.

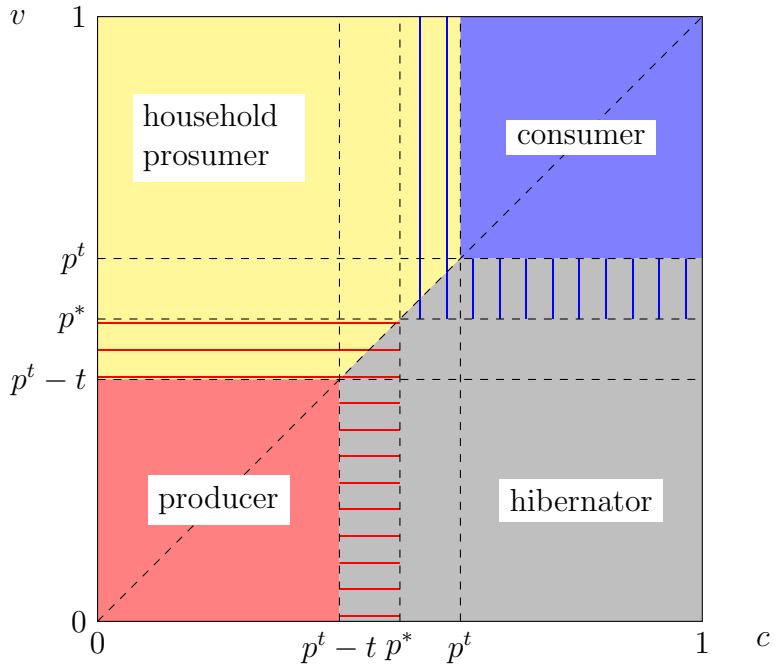
Because $t > 0$, any prosumer will strictly prefer to be a household prosumer who produces and consumes (payoff $v-c$) to a market prosumer who supplies to and consumes from the market (payoff $v - p + p - c - t = v - c - t$). Given market price p, an agent

Figure 6: Flat market production tax

(a) Production and consumption decisions with producer tax



(b) Equilibrium with producer tax versus benchmark equilibrium



chooses to be a prosumer if

$$\begin{aligned} \text{prosuming is better than hibernating:} \quad & v - c > 0; \\ \text{prosuming is better than producing:} \quad & v - c > p - c - t \Rightarrow v > p - t; \text{ and} \\ \text{prosuming is better than consuming:} \quad & v - c > v - p \Rightarrow c < p. \end{aligned}$$

Figure 6a illustrates the conditions for prosumption: $v > p - t$, $v - c > 0$, and $c < p$. A combination of sufficiently low value and cost makes an agent a sole producer, and a combination of high value and cost makes an agent a sole consumer.

Under uniform distributions, equilibrium price is determined by $S(p) = (p - t)^2$ and $D(p) = (1 - p)^2$. Hence, equilibrium price is $p^t = (1 + t)/2$, and producers effectively receive $p^t - t = (1 - t)/2$. Compared to the benchmark case, the mass of prosumers increases by

$$[(p^*)^2 - (p^t - t)^2]/2 + [(1 - p^*)^2 - (1 - p^t)^2]/2.$$

The market size—the mass of both consumers and producers—shrinks by $[(p^*)^2 - (p^t - t)^2] = [(1 - p^*)^2 - (1 - p^t)^2]$. Half of them become prosumers and half of them hibernate.

We evaluate total social welfare next. We should sum up the welfare of prosumers, consumers, and producers, as well as that of government tax. Total consumption is

$$\mathbf{q}^t = 1 - [(1 - p^t - t)p^t - t^2/2] - (p^t - t)^2 = 1 - [(1 - t)^2/2 - t^2/2] - (1 - t)^2/4.$$

Society supply when facing effective price $p' = p - t$ is

$$\mathbf{S}(p') = \begin{cases} p' + [(1 - p') + (1 - p' - t)]t/2 = p' + (1 - p' - t/2)t & \text{if } p' < 1 - t, \\ p' + (1 - p')^2/2 & \text{if } p' \geq 1 - t. \end{cases}$$

Society demand is

$$\mathbf{D}(p) = \begin{cases} 1 - p + (p + p - t)t/2 = 1 - p + (p - t/2)t & \text{if } p \leq 1, \\ [1 - (p - t)^2]/2 & \text{if } p \in [1, 1 + t]. \end{cases}$$

Market consumer surplus is

$$\int_{p^t}^{1} (v - p^t)(1 - p^t) dF_v(v) = (v^2/2 - p^t v)(1 - p^t)|_{p^t}^{1} = (1/2 - p^t + (p^t)^2/2)(1 - p^t) = (1 - p^t)^3/2.$$

Market producer surplus is

$$PS_m^t = \int_0^{p^t - t} (p^t - t - c) dF_c(c) = [(p^t - t)c - c^2/2]\big|_0^{p^t - t} = (p^t - t)^2.$$

3.2 Subsidies

Suppose producers are given a subsidy σ on goods transacted on the market.

Every prosumer prefers being on the market to being a household prosumer. Given price p, an agent chooses to be a prosumer if it is better than

$$\begin{aligned} \text{hibernating: } & v - c + \sigma > 0 \\ \text{producing: } & v - c + \sigma > p - c + \sigma \Rightarrow v > p \\ \text{consuming: } & v - c + \sigma > v - p \Rightarrow c < p + \sigma \end{aligned}$$

The latter two inequalities imply the first one, so an agent is a prosumer if $v > p$ and $c < p + \sigma$. In equilibrium, the price incurred by the consumer is $p^s < p^*$ and the producers receive $p^s + \sigma$. See Figure 7.

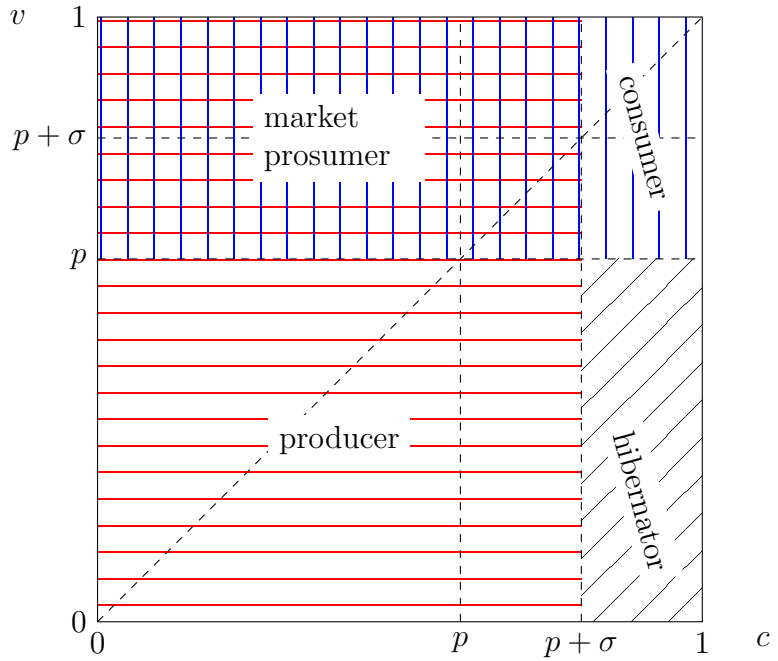
Compared to the competitive equilibrium, three types of agents convert to (market) prosumers: (i) producers with valuations between p^s and p^* and costs below p^* not only produce but also consume given the reduction in effective consumption price from p^* to p^s; (ii) consumers with costs between p^* and $p^s + \sigma$ not only consume but also produce, given the increase in effective production price from p^* to $p^s + \sigma$. In addition, some hibernators, given the higher price for production and lower price for consumption, produce and consume, respectively.

3.3 Price ceiling

Suppose there is a price ceiling $\overline{p} < p^*$. There will be strictly more demand and strictly less supply than in competitive equilibrium. Hence, there will always be excess demand, and goods need to be allocated by rationing among willing consumers. See Figure 8. Namely, individuals with production costs higher than $\overline{p}$ and lower than v would first try their luck obtaining the good on the market. If they do not receive a good, they can produce on their own. For individuals with a valuation above $\overline{p}$ but lower than their production cost, they try obtaining the good in the market; if not, they do not produce or consume.

Figure 7: Flat market production subsidy

(a) Production and consumption decisions with producer subsidy



(b) Equilibrium with producer subsidy versus benchmark equilibrium

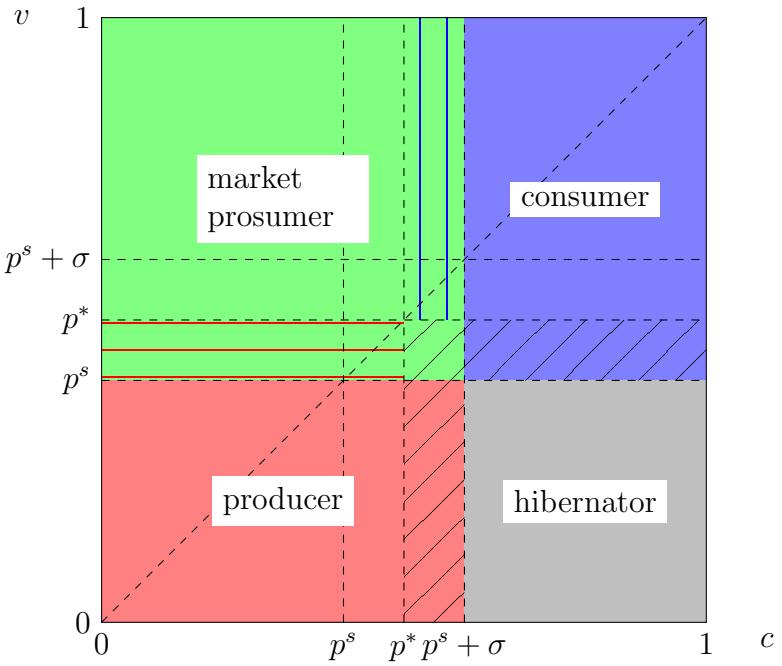
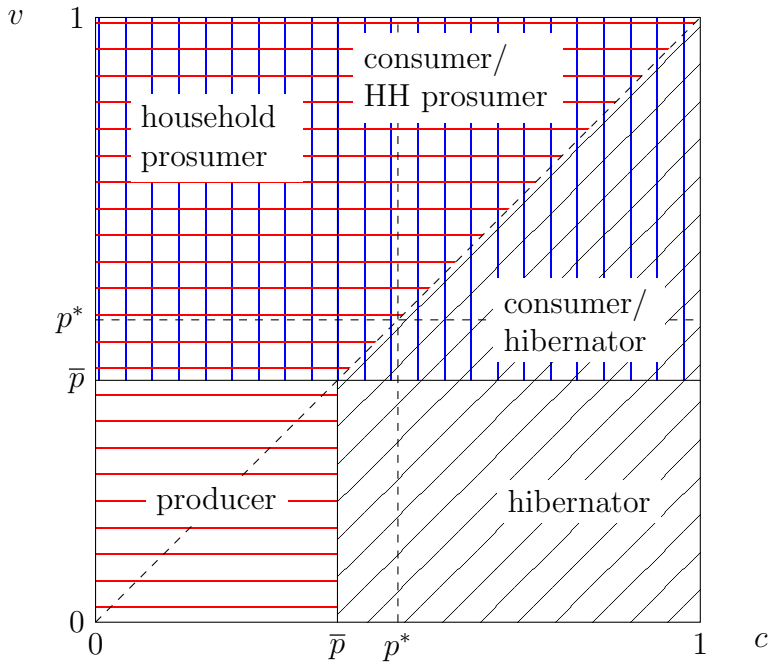
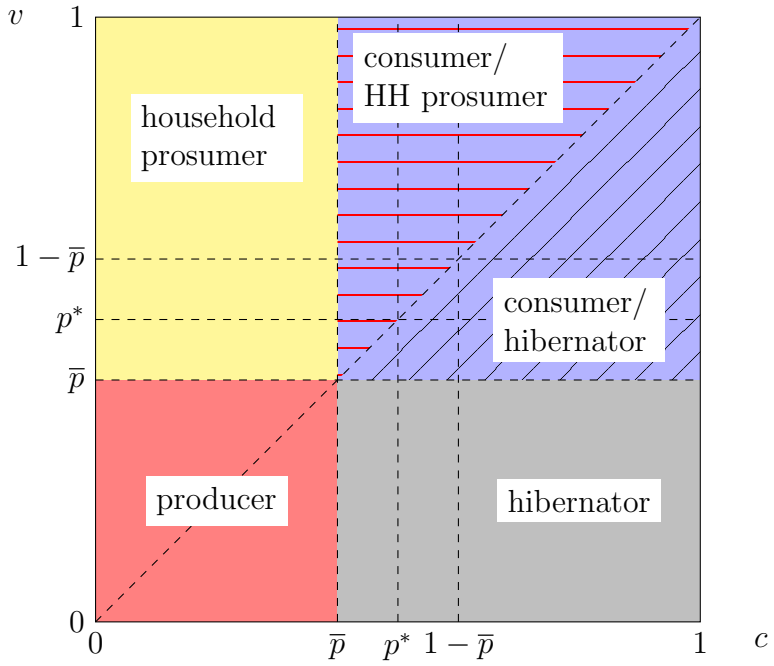


Figure 8: Price ceiling

(a) Production and consumption decisions with price ceiling



(b) An equilibrium with price ceiling $\overline{p} < p^*$



4 Analysis under asymmetric information

4.1 Production choice with binary quality

It costs $c_L \geq 0$ to produce a low-quality good, and costs $c_H = c_L + c$, where $c \in [\underline{c}, \overline{c}] = [0, 1]$, to produce a high-quality good. Consumption value for a low-quality good is 0 and for a high-quality good is v, where $v \in [\underline{v}, \overline{v}]$. We consider unit consumers and unit producers.

Given market price p, a producer is willing to supply a high-quality good to the market if $p - c_H > \max\{v - c_H, 0\}$, and is willing to supply a low-quality good to the market if $p - c_L > 0$. When facing a choice, *a producer is always strictly more willing to supply a low-quality good*. Hence, if there is any supply of goods on the market, they will be of low quality and worth 0. As a result, no individual is willing to supply a high-quality or low-quality good on the market.

The only consumption is through household prosumption. As a result, anyone whose cost c of producing a high-quality good is lower than their valuation v for the good will produce and consume (Figure 9b).

4.2 Continuum quality

4.2.1 Competitive equilibrium

Suppose now that agents can choose to produce any quality $q \in [\underline{q}, \overline{q}]$. Similar to the logic of Akerlof (1970), market collapses. Namely, in the absence of ways to distinguish their product, no producer is willing to produce a high-quality for the market.

4.2.2 Subsidy

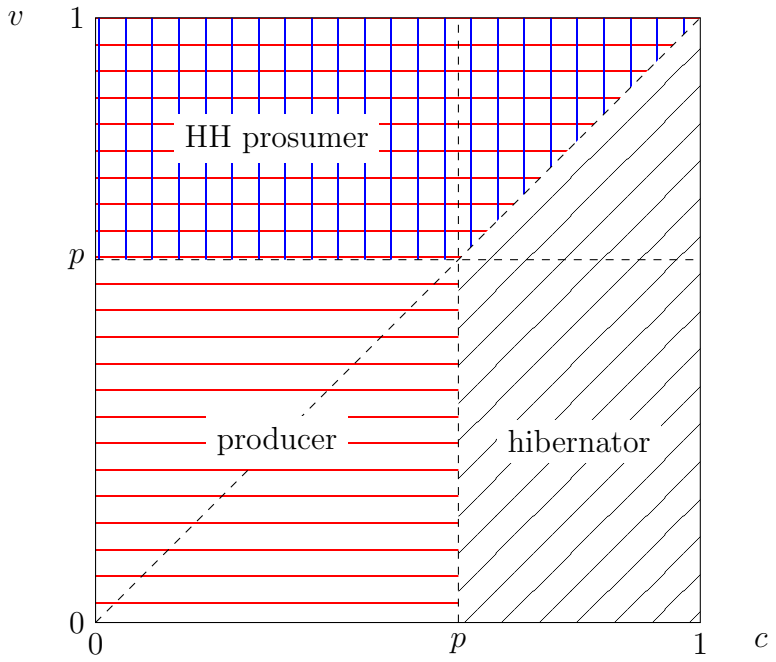
Suppose there is a market subsidy $\sigma \geq 0$ per unit. Let Q denote the average quality of the good on the market. For consumers to be willing to produce, we need $p \leq Q$ and for producers to be willing to consume, we need $Q \geq p$. In equilibrium, the market price is $p^* = \mathbb{E}[q | q < p^* + \sigma]$. When $p \sim U[0, 1]$, $p^* = \sigma$. See Figure 10b. A subsidy σ creates a small market of size σ^2.

4.3 Contaminated products

There are two ways to model this: (i) a fixed amount of L of low-quality product enters the market; (ii) with probability λ, a good becomes low-quality when transacted in the

Figure 9: Asymmetric information: binary quality

(a) Production and consumption decisions under asymmetric information



(b) Equilibrium under asymmetric information: market collapses

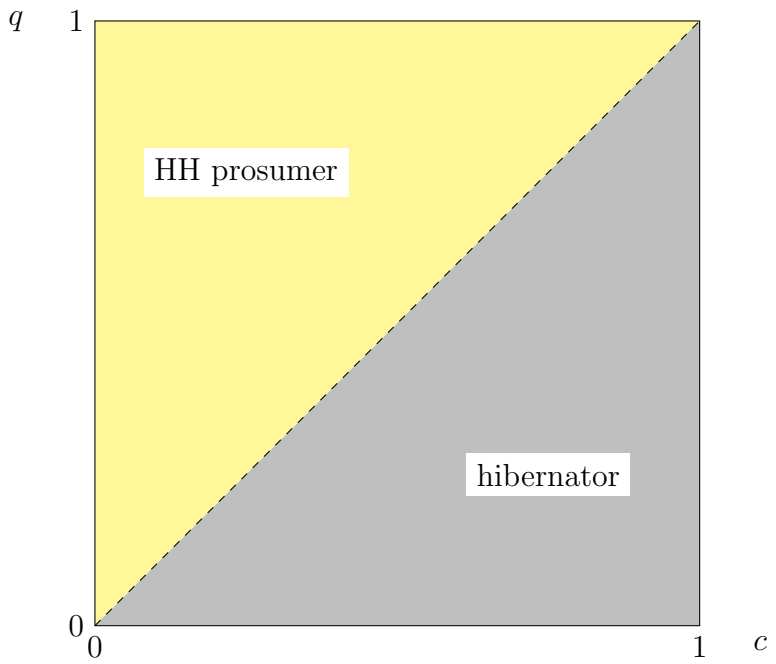
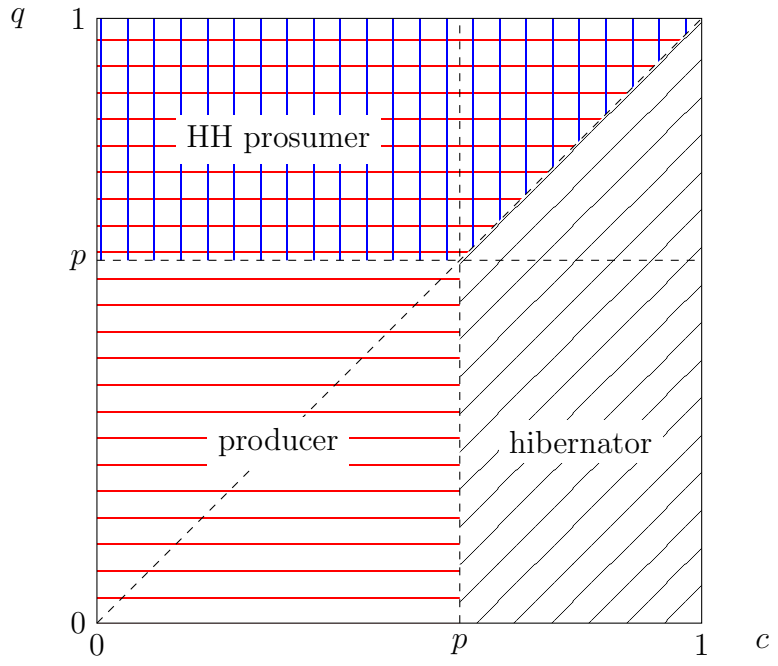
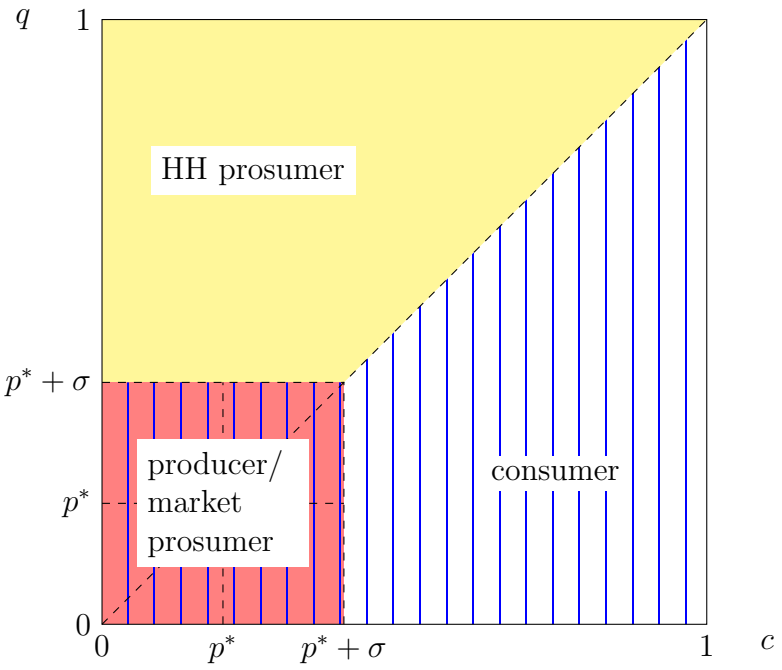


Figure 10: Asymmetric information: continuum quality and subsidy

(a) Production and consumption decisions under asymmetric information and subsidy



(b) Equilibrium under asymmetric information and subsidy



$\mathbb{E}[q|q < p^* + \sigma] = p^*$. If $q \sim Unif[0, 1]$, then $p^* = \sigma$.

market. This way, producers still have an incentive to sell in the market.

5 Conclusion

In this paper, we study prosumers, individuals who simultaneously produce and consume a specific good or service. In particular, we conduct a general equilibrium analysis of markets with the possibility of prosumption. We introduce shadow supply and demand curves to facilitate our analysis.

Finally, there are markets without prices. For example, internet users engage in both producing and consuming content, services, and products on digital platforms. For user-generated content, internet users create content (e.g., social media posts, videos, blogs, reviews) that others consume. Platforms like YouTube, Instagram, and TikTok rely heavily on prosumers to generate and share material that drives engagement and traffic. Collaborative platforms such as Wikipedia, forums, and open-source projects (for example, GitHub) thrive on users contributing knowledge and resources while simultaneously consuming what others have shared. In general, simply by using digital services, internet users generate data (search queries, purchase histories, browsing behaviors) that companies monetize.

References

Akerlof, George A. 1970. "The market for 'lemons': Quality uncertainty and the market mechanism." *Quarterly Journal of Economics* 84 (3):488–500.

Becker, Gary S. 1965. "A theory of the allocation of time." *Economic Journal* 75 (299):493–517.

———. 1993. *A Treatise on the Family: Enlarged Edition*. Harvard University Press.

Bridgman, Benjamin, Andrew Dugan, Mikhael Lal, Matthew Osborne, and Shaunda Villones. 2012. "Accounting for household production in the national accounts, 1965–2010." *Survey of Current Business* 92 (5):23–36.

Ertz, Myriam, Xinyuan Cao, and José Maria Barragán Maravilla. 2024. "The prosumer." *Encyclopedia* 4 (3):1263–1278.

Gautier, Axel, Julien Jacqmin, and Jean-Christophe Poudou. 2018. "The prosumers and the grid." *Journal of Regulatory Economics* 53 (1):100–126.

Inês, Célia, Guilherme P. Luz, Esther M. Palomar, Swantje Gährs, Stephen Herbes, and Lars Holstenkamp. 2020. "Regulatory challenges and opportunities for collective renewable energy prosumers in the EU." *Energy Policy* 138:111212.

Kuznets, Simon. 1934. *National Income, 1929-1932*. New York: National Bureau of Economic Research.

List, John A., Ioannis C. Pragidis, and Michael K. Price. 2024. "Toward an understanding of the economics of prosumers: Evidence from a natural field experiment." National Bureau of Economic Research Working Paper 32837.

Parag, Yael and Benjamin K. Sovacool. 2016. "Electricity market design for the prosumer era." *Nature Energy* 1 (4):1–6.

Perera, Chamila R., Chandana R. Hewege, and Cai V. C. Mai. 2020. "Theorising the emerging green prosumer culture and profiling green prosumers in the green commodities market." *Journal of Consumer Behaviour* 19 (4):295–313.

Pless, Jacquelyn. 2025. "Prosumers, Real-Time Pricing, and Disentangling Inattention from Uncertainty." Mimeo.

Ritzer, George. 2015. "Prosumer capitalism." *Sociological Quarterly* 56 (3):413–445.

Rustagi, Devesh. 2024. "Market exposure, civic values, and rules." Mimeo.

Tirole, Jean. 2012. "Overcoming adverse selection: How public intervention can restore market functioning." *American Economic Review* 102 (1):29–59.

Toffler, Alvin. 1980. *The Third Wave*. New York, New York: William Morrow.

Toffler, Alvin and Heidi Toffler. 2006. *Revolutionary Wealth*. New York: Knopf.

Zhou, Li, Bei Liu, Zongzhi Liu, and Jinhua Zhao. 2024. "Farmers as prosumers: Evi-

dence from cadmium-contaminated rice in China." *American Journal of Agricultural Economics* 1-20.