

# **Neoclassical Supply and Demand, Experiments, and the Classical Theory of Price Formation**

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# **Orientation: Classical economic representation of agents (buyers and sellers) in markets:**

**Commodity space is discrete; transactions involve single units. (Think of a shopping basket with 1 qt. milk, # bacon, jar olives, box of cereal...our model allows but does not require multiple units.)**

**Buyers each value a unit of a good, measured by the maximum amount of money they are willingness to pay for it.**

**In aggregate, think of buyers defined by a distribution function values,  $v = d(Q)$ ; sellers each have minimum willingness to accept  $c = s(Q)$ ;  $d$  is non-increasing (order property of a DF); similarly  $s(Q)$  is non-decreasing.**

**Price is not in these DFs because  $P$  has not yet been found by “higgling and bargaining” in the market.**

# WHAT THIS TALK IS ABOUT

- \*Role of experiments in discovering the failure of the neoclassical MU paradigm to predict experimental outcomes.**
- \*Revisiting classical value theory, i.e., the price formation discovery process as viewed by classical economists.**
- \*Formalizing the content of classical value theory**

**PART I: DISCOVERING THE  
FAILURES OF NEOCLASSICAL MICRO  
ECONOMICS VIA EXPERIMENTS**

# Characteristics of early market experiments

- **Small numbers**
- **Each subject assigned one unit (or a few)**
- **DA (oral outcry) trading rules (exogenous to economics)**
- **Private decentralized value/cost information**
- **Zero public information**
- **Subjects Naïve in Economics**
- **Prices unexpectedly converged to approximate a S&D clearing price, a point or set of points pre-defined in the experiments. Mid 20<sup>th</sup> century economic theory was unprepared for this.**

**Sources of inspiration that led to design of first experiments; note the (flawed) belief that they were rooted in “Neo-classical” economics:**

**(1) Jevons (1862; 1871) provided the background: Max U given prices and income. Imposes theory, law-of-one-price in mkt on D&S; on derivation of demand. But the first implementations were with discrete units and had no utilitarian connection (Smith, 1962). A later, mostly *methodological* reconstruction, introduced continuous differentiable commodity spaces and the concept of “induced valuation.” (Smith 1976)**

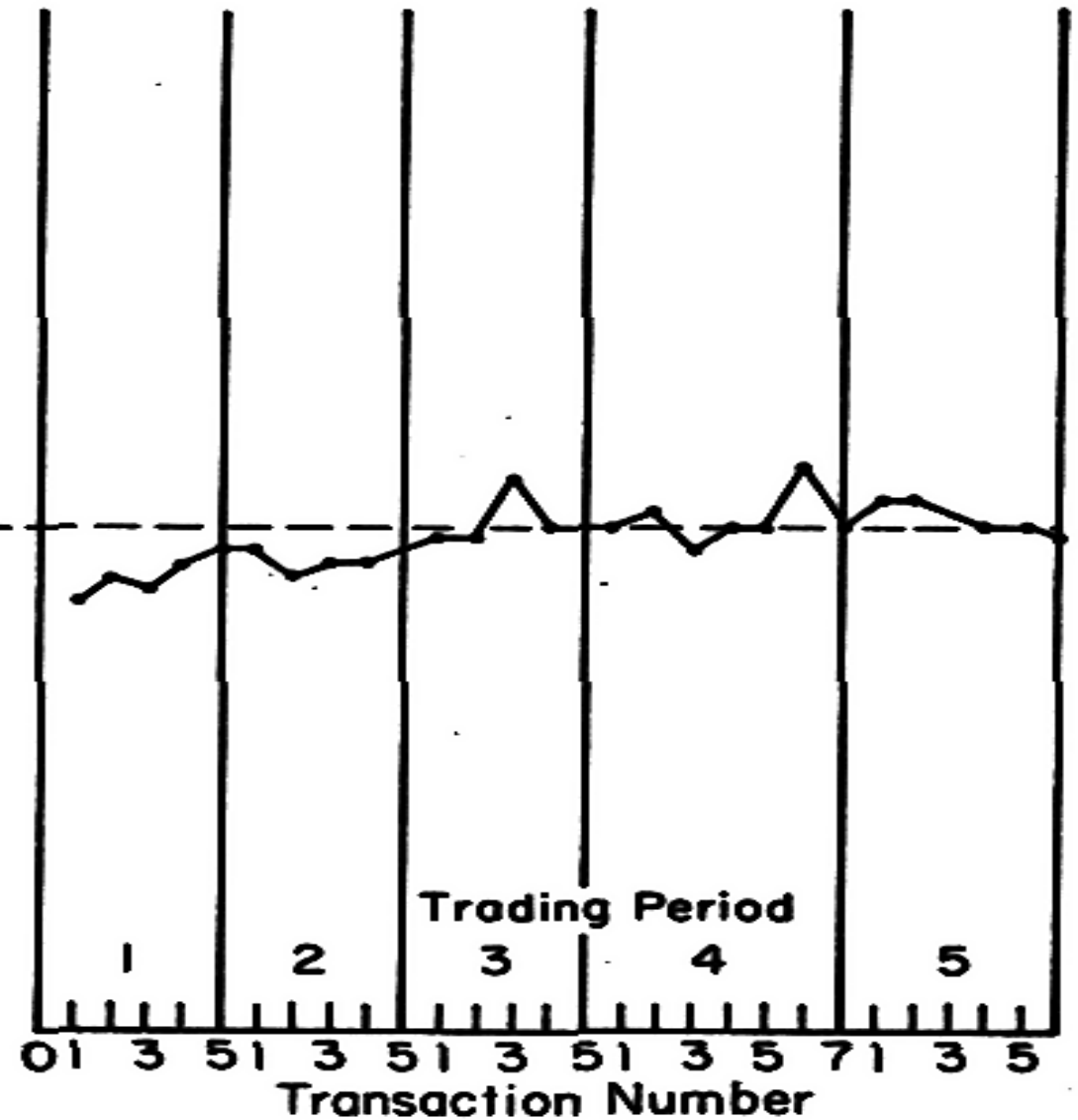
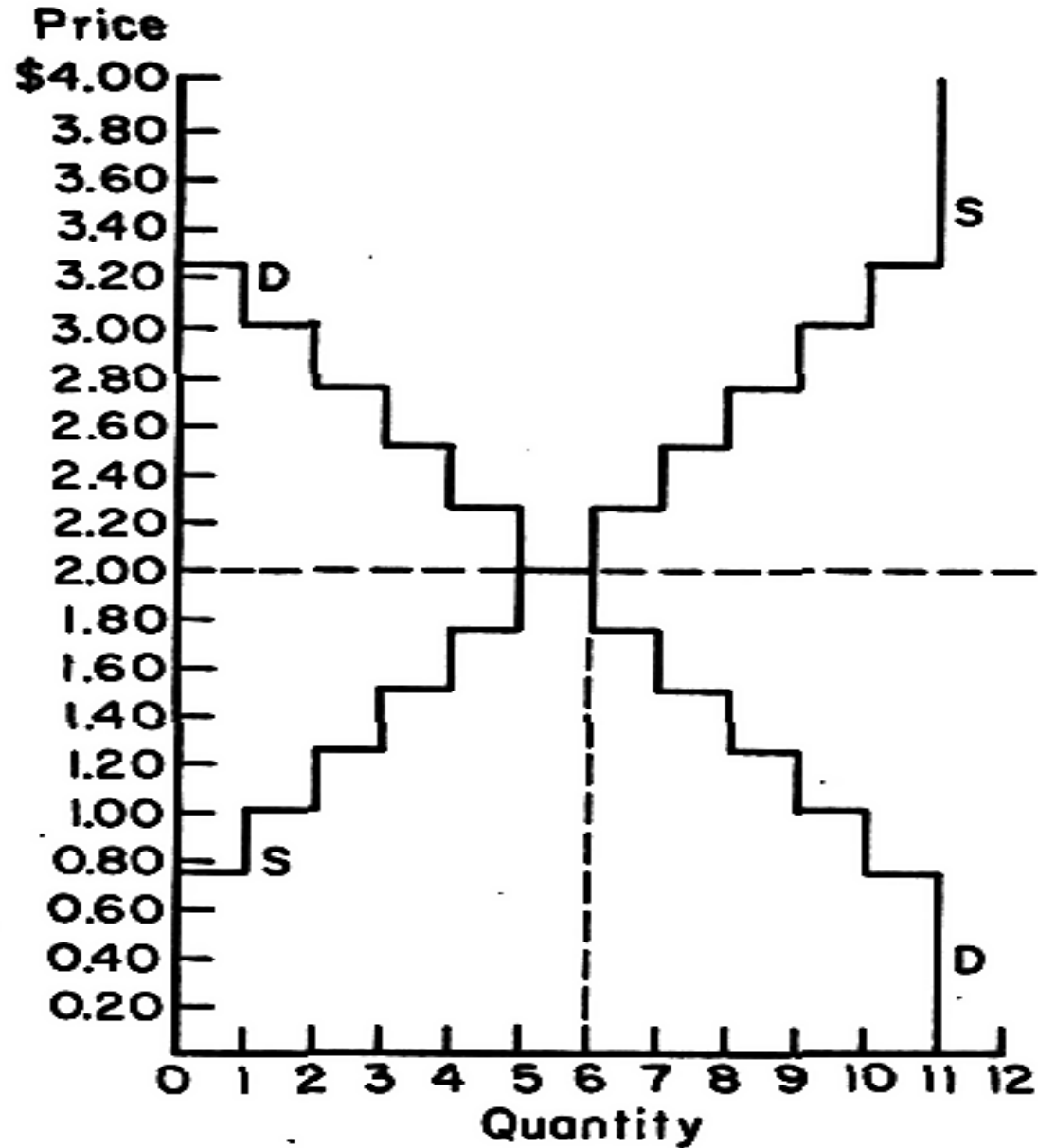
**(2) The context was consciously in the tradition of Marshall (1890) in that S&D operated as flows over successive pricing periods in the belief that if equilibrium is to be given its best shot, it must somehow involve learning and adjustment over time.**

**(3) Chamberlin's (1948) experiments had pioneered the WTP/WTA reservation-price procedure; "tickets" were used to represent S&D, "Marshall's Demand (or S) price." (Also was in Menger/Bohm-Bawerk, but that was found much later.). And "prices...are not subject to 'recontract' (thus perfecting the market)" [Edgeworth's concept, but not cited by Chamberlin].**

**(4) Finally, prices formed endogenously & spontaneously among the participants, in a *decentralized collective search for economic value* via the bid-ask continuous "oral double auction" protocol long operating in the Chicago commodity markets and New York Stock Exchange. (Leffler, 1951) We discovered convergence toward but NOT "the law of one price."**

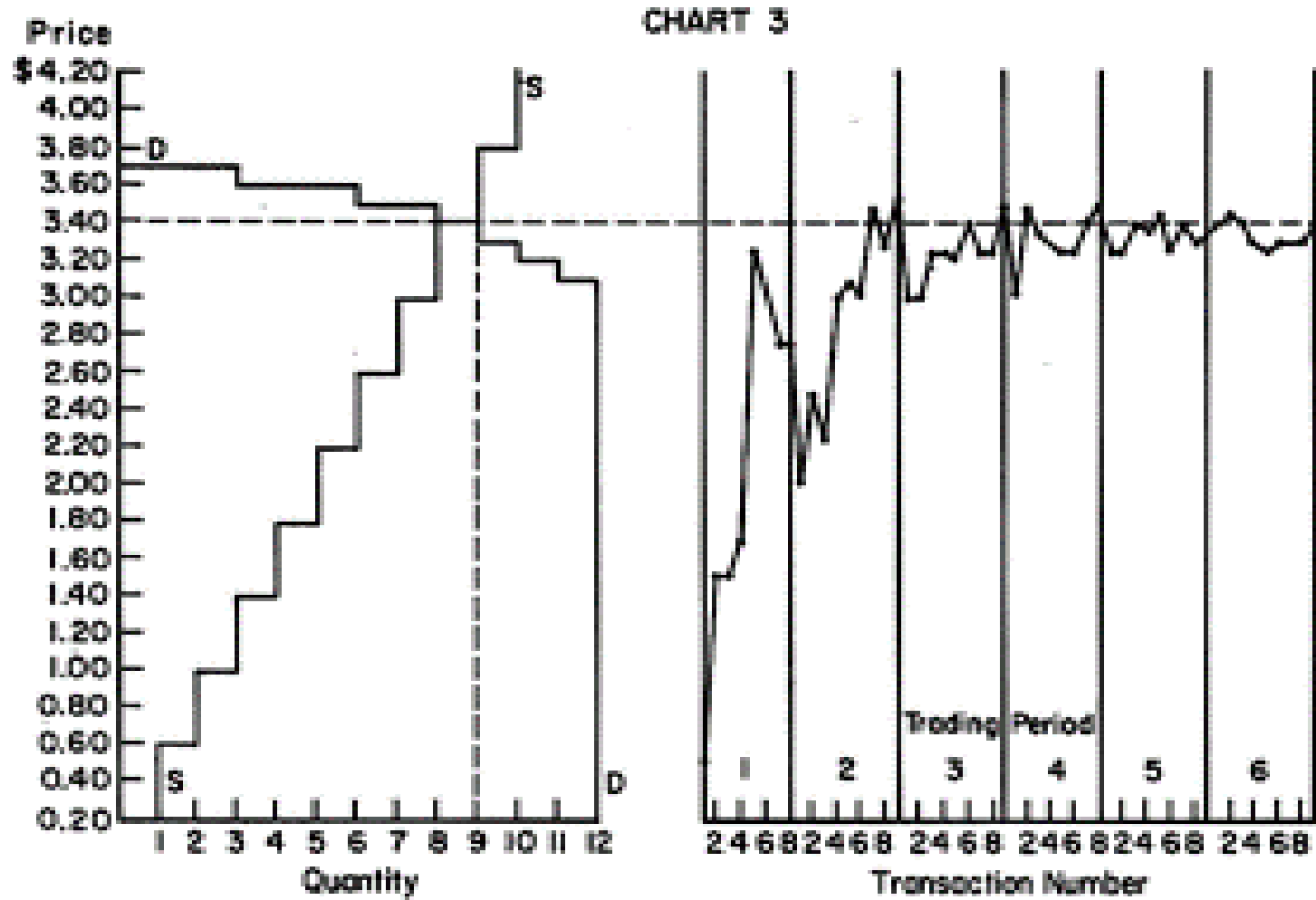
# First experiment; January 1956; artifact of symmetry?

CHART I





# Convergence not an artifact of S & D symmetry



**What was the mechanism of convergence? Excess demand vs excess Rent.**

Empirically, Price Adjusts Proportional to Excess Rent,  $E$ , minimized in equilibrium; i.e., market minimizes the profit required to satisfy all “effectual” demand.

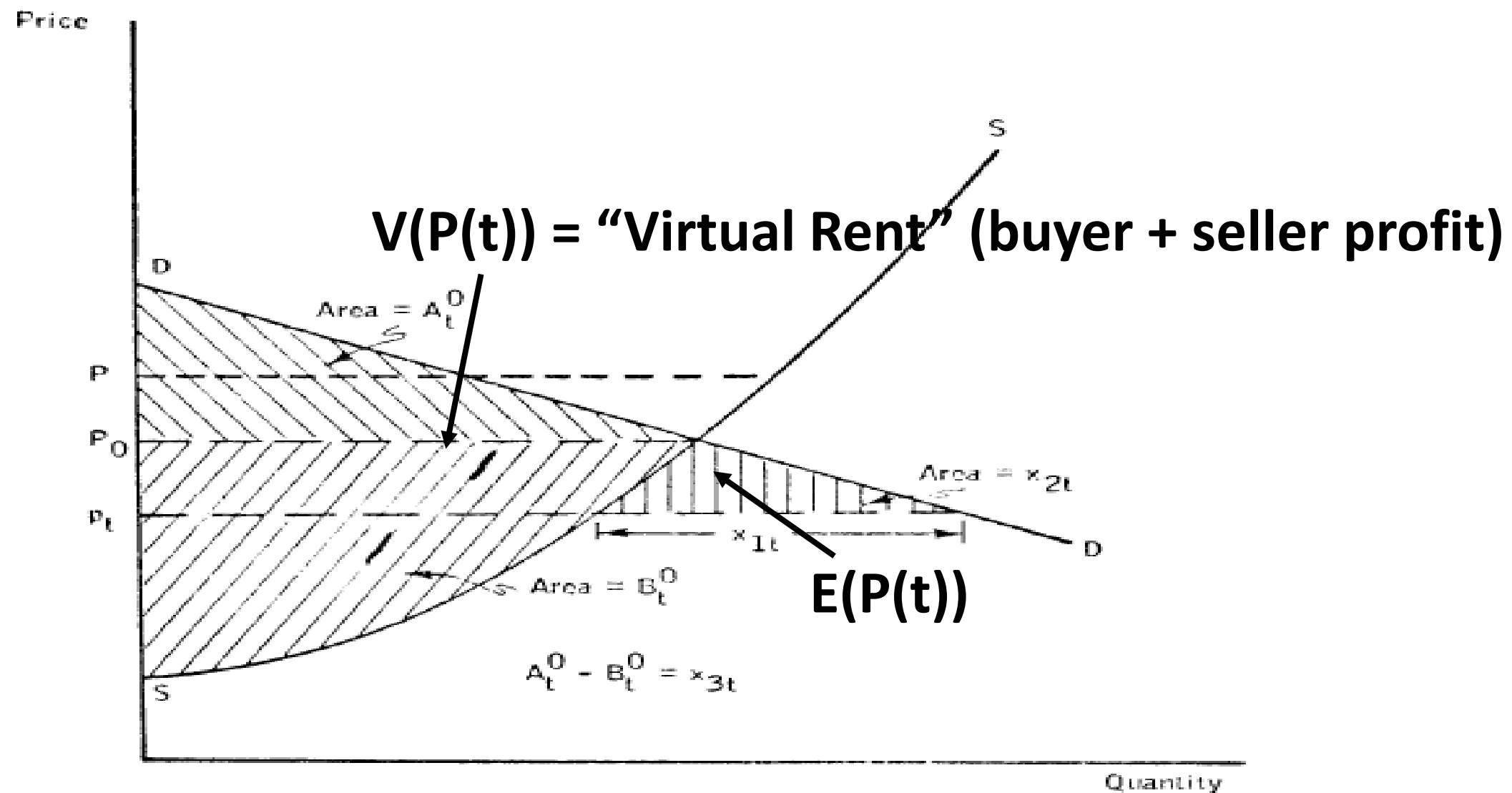
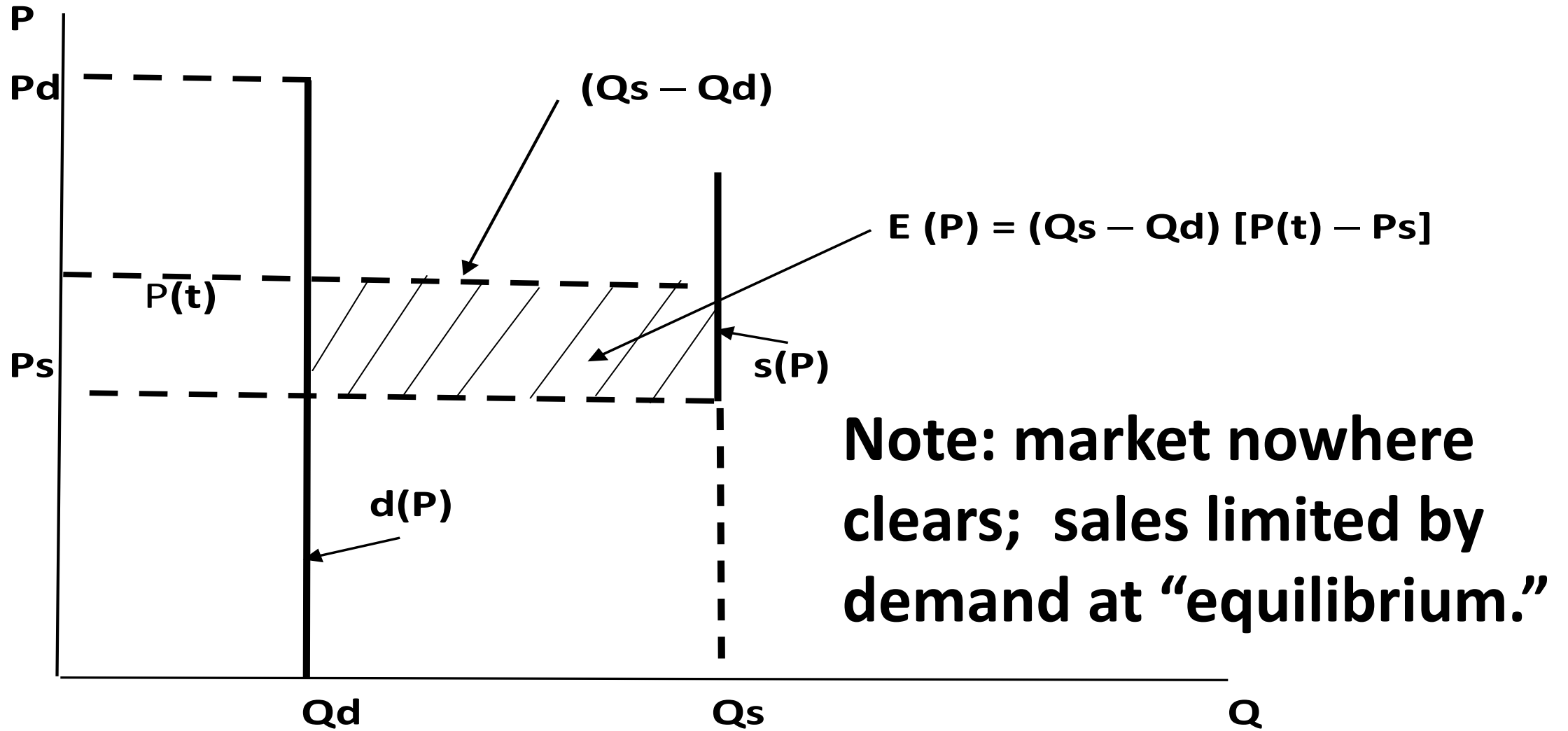


FIG. 1

**Figure 2. S&D for Testing WH against ERH**



# Testing WH Against ERH (Smith, 1965); $e = 2, 5, 8$ . Finding: ERH beats WH (Smith, 1965, p 392)

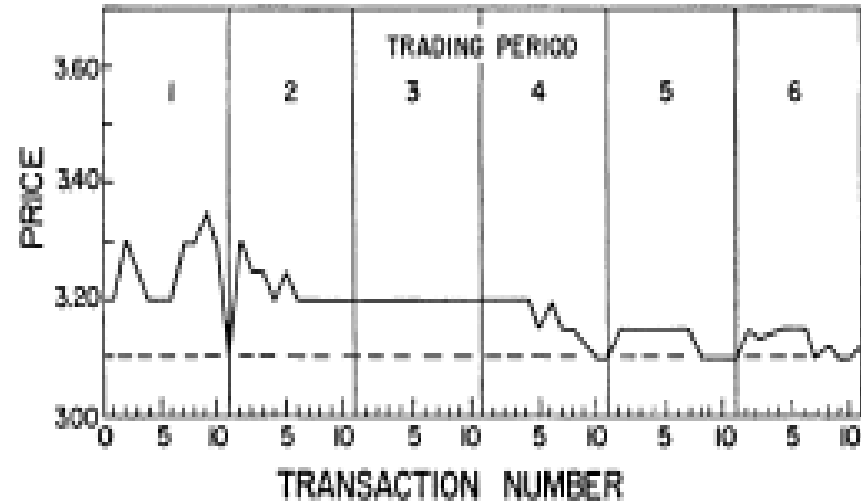


FIG. 1A.—Experimental session 1,  $e = 2$

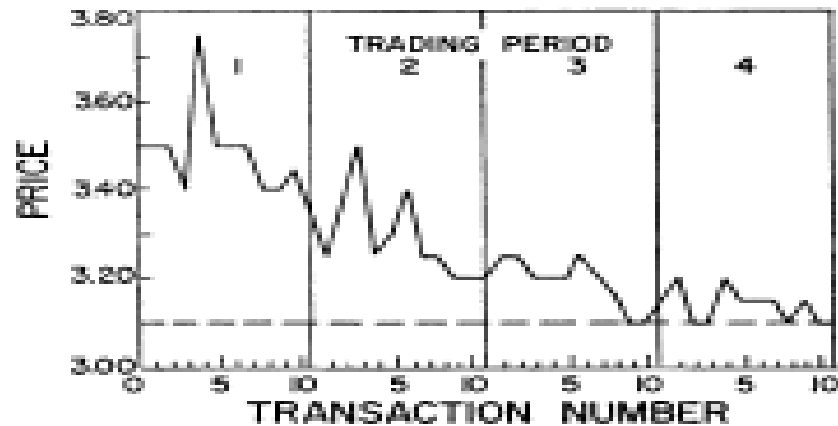


FIG. 1C.—Experimental session 3,  $e = 5$

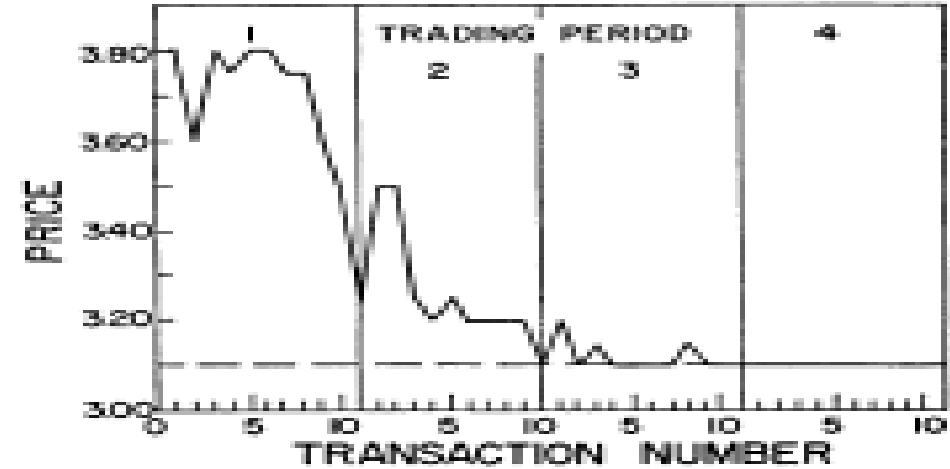


FIG. 1D.—Experimental session 4,  $e = 5$

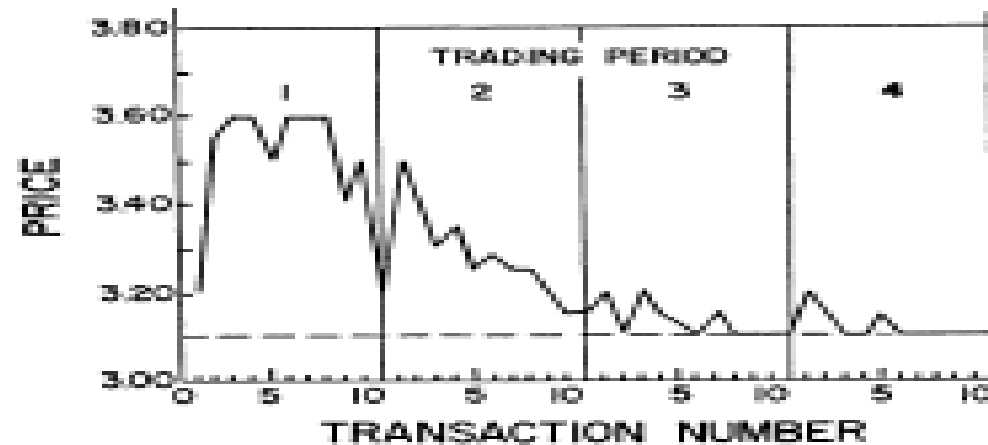


FIG. 1F.—Experimental session 6,  $e = 8$

# **SUMMARY; NEOCLASSICAL ECONOMICS**

- **Jevons/Walras had no theory of market price discovery.**
- **Had only a Max U theory of quantity choices, given prices/incomes.**
- **Imposed the theory “law of one price” on demand (supply)**
- **Jevons thought complete, perfect information on theory needed!**
- **Walras imagined an exogenous agent, who announced given prices.**
- **Famous debate: socialists argued state sets prices by trial & error!**
- **Marshall/Menger/Bohm-Bawerk all articulated price discovery processes, but these depended in no way on marginal utility; rather only on WTP/WTA reservation prices.**
- **Constrained  $U(.)$  and “income effects” first enter demand theory.**

**An improvement on classical economics?**

# **PART II WHAT IS CLASSICAL ECONOMICS?**

# **Classicalism: Smith to Cournot; about price discovery processes**

**Goods have value in use (measured by demand), value in exchange (price)**

**Value in use: Value = Max WTP (Q) reservation values (“effectual demand”)**

**Realistic: Quantities are discrete; most consumer purchases are for 1 or 2 units!**

**Value in exchange depends on competition/entry by producers; diamond price high due to monopoly; iron or water price low because many producer-entrants.**

**If quantity brought to market “falls short of effectual demand...those willing to pay” the supply price “cannot be supplied;” some will bid for what they can get, and price will increase. (Sales limited by supply) Smith (1776, p 73)**

**If quantity brought exceeds demand, cannot all be sold to buyers willing to pay the supply price, and price falls (Sales limited by demand) Smith (1776. p 74)**

**Implies that price change has same sign as excess demand. At any price contracted quantity limited by minimum of amount demanded or supplied.**



# PART III: CLASSICAL THEORY OF MARKETS

1. Motivation: Individuals have Max WTP (Min WTA) values (costs); try to buy cheap, sell dear.
2. Price adjustment is dynamic: Price change and excess demand,  $e(P)$ , have the same sign:  
 $e(P) \Delta P / \Delta t > 0$  if  $e \neq 0$ . Price changes if excess demand is not zero.

$V(P)$  = integral of  $-e(P)$ , is profit required to sustain  $P$ .  $\Delta V / \Delta t = -e(P) \Delta P / \Delta t \leq 0$

For discrete values and costs,  $V(P) = \sum_i (v_i - P)d_i(P) + \sum_k (P - c_k)s_k(P)$

Or equivalently  $V(P) = \sum_i |v_i - P|d_i(P) + \sum_k |c_k - P|s_k(P)$

So  $V$  = overall (weighted) distance between price and the traders' valuations (namely their reservation prices).  $V(P)$  is a measure of "Distance" in profit space.

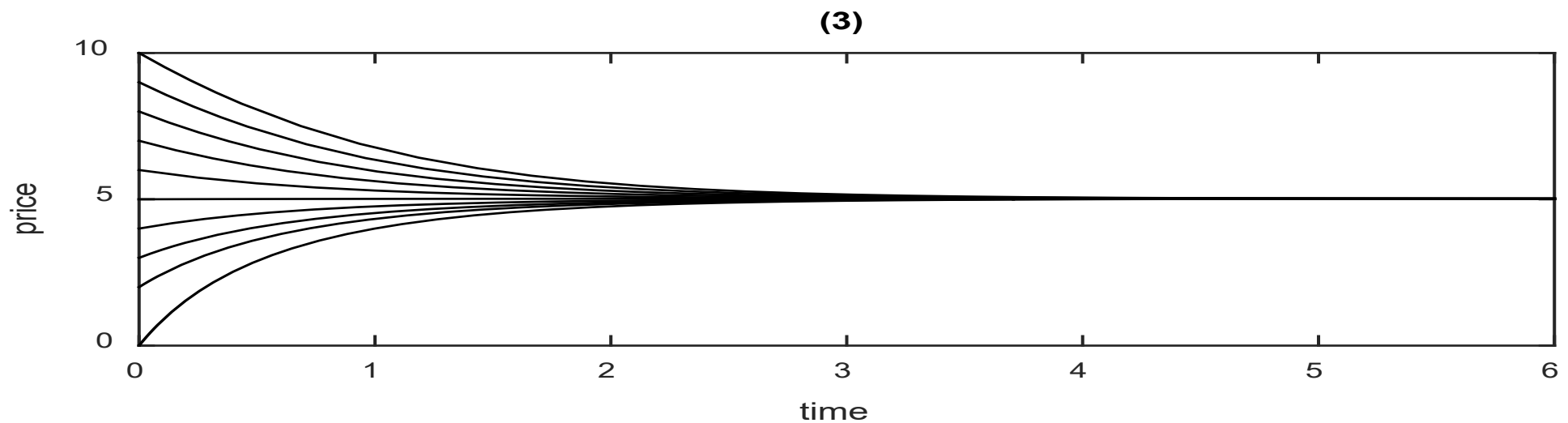
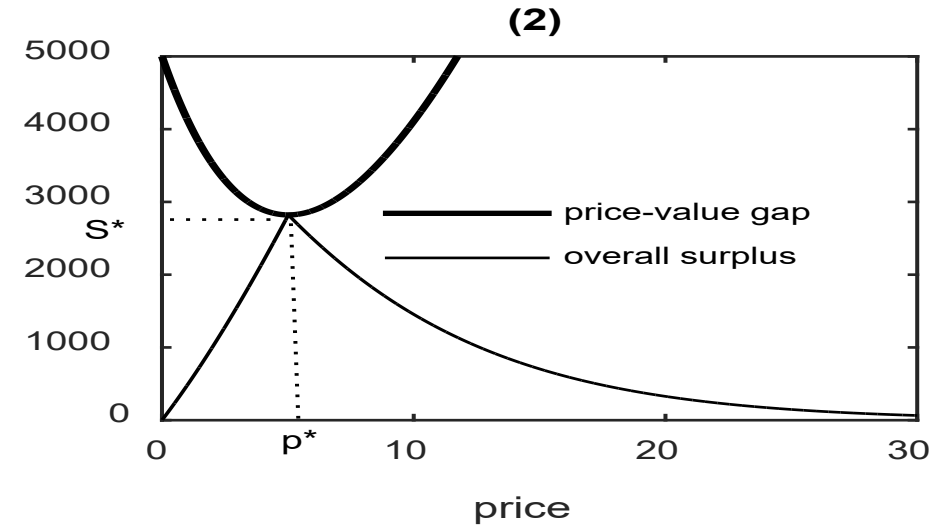
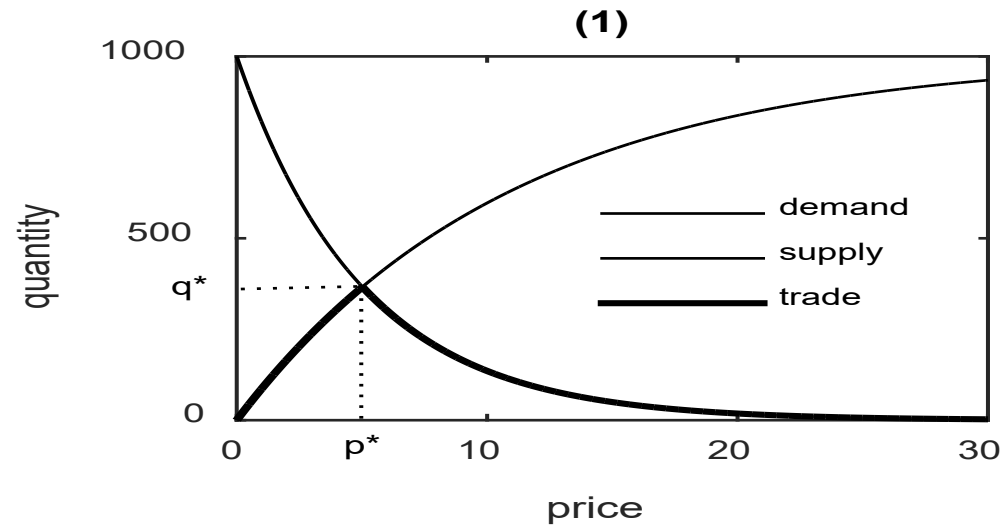
3. (Short-side principle) Quantity traded is the minimum between quantity supplied and quantity demanded,  $\min[s(P), d(P)]$ .

$TS(P)$  = surplus constrained by short-side rationing = surplus (profit) realizable at market price  $P$ .  $V$  is a Liapunov function, and  $P(t) \rightarrow P^*$ , (converges nonparametrically to center of value,  $P^*$ ) where price change is zero, and  $P^* = \arg \min V(P) = \arg \max TS(P) = \arg \max (\min [s(P), d(P)])$ .

*Principle of maximum information:* "Market  $P(t)$  evolves so as to reflect value better and better":  $\Delta V(t) \leq 0$ . The distance between price and value decreases through competition. Thus the classical foundations of Hayek, Hurwicz-Reiter-Radner on informational efficiency

**THEOREM : Assume a competitive market (in the classical sense, not price taking!). Assume no re-trading takes place (hence no speculation). Then price converges to minimum price-value distance, maximum trade, and maximum surplus.**

Illustration: large market with values and costs drawn from exponential distributions

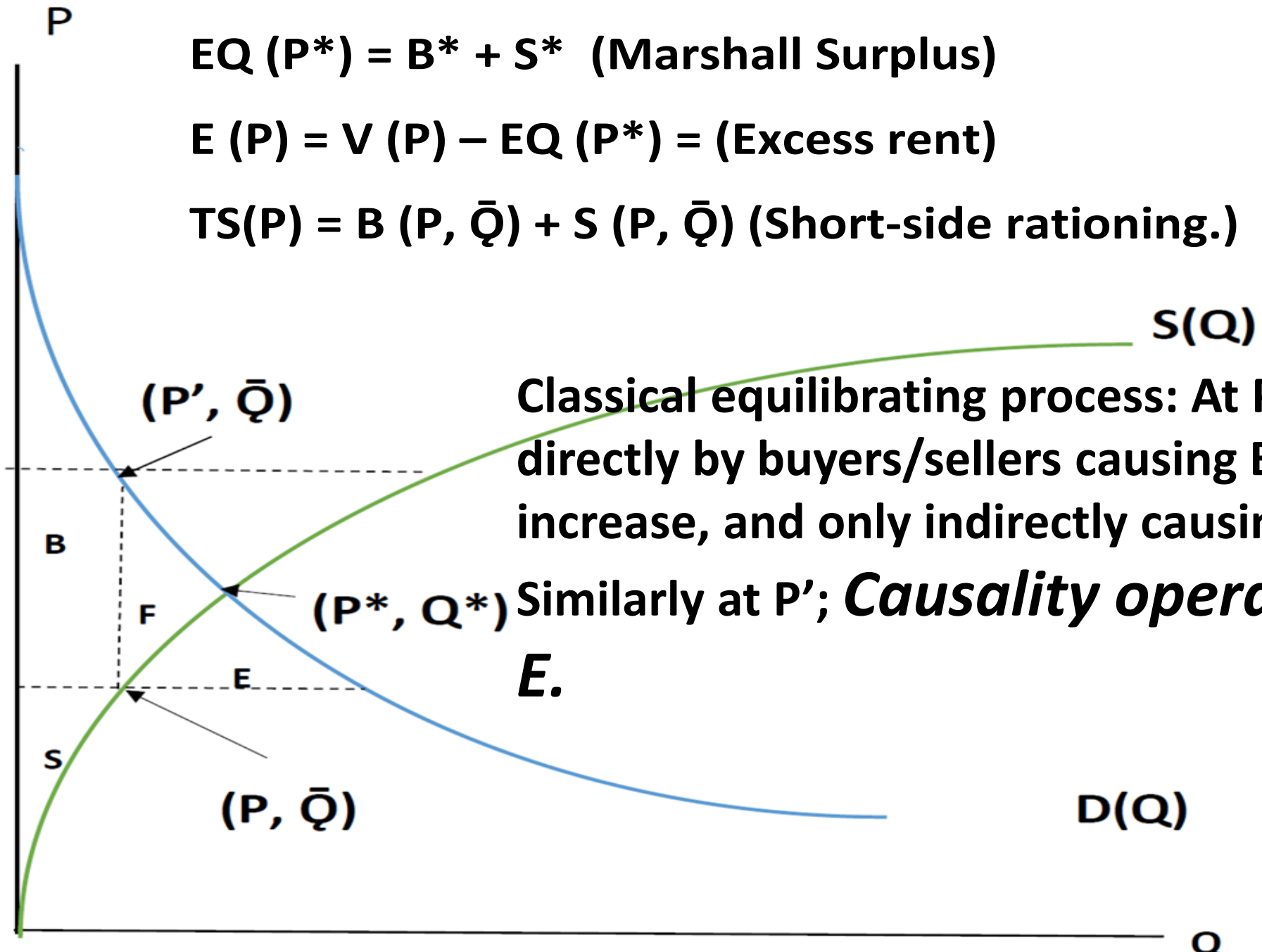


$$V(P) = B + F + S + E \quad (\text{Liapunov fn.})$$

$$EQ(P^*) = B^* + S^* \quad (\text{Marshall Surplus})$$

$$E(P) = V(P) - EQ(P^*) = (\text{Excess rent})$$

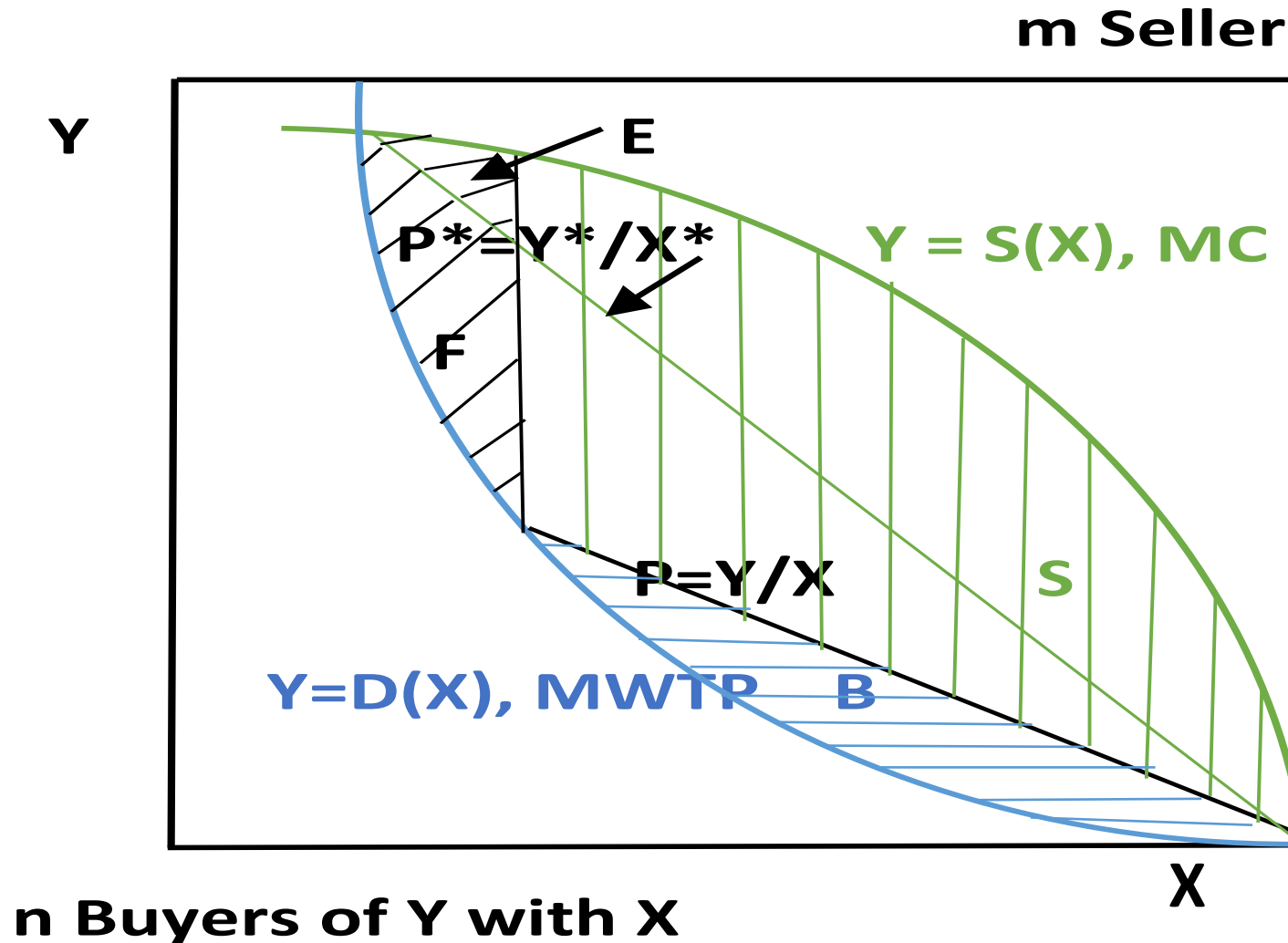
$$TS(P) = B(P, \bar{Q}) + S(P, \bar{Q}) \quad (\text{Short-side rationing.})$$



Classical equilibrating process: At P, set F is invaded directly by buyers/sellers causing B and S to increase, and only indirectly causing E to shrink.

Similarly at P'; ***Causality operates on F, not E.***

# Classical Edgeworth Box: Goods X and Y

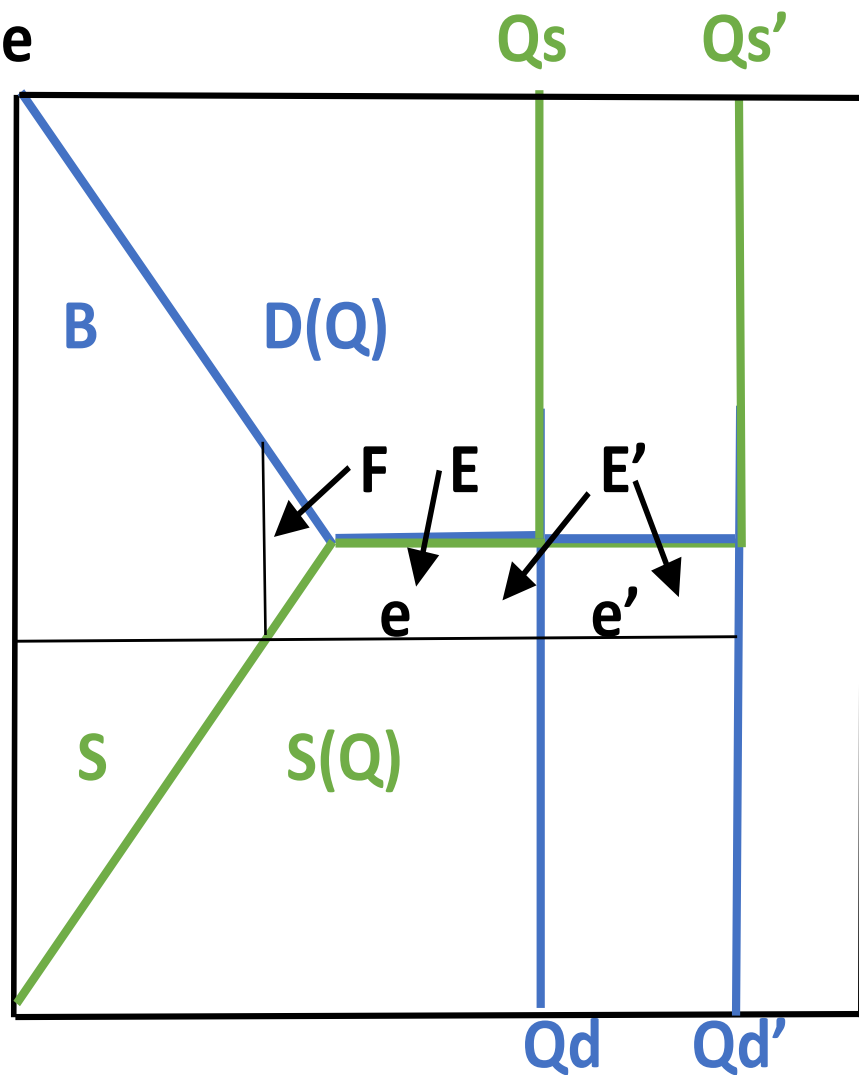


Classical general equilibrium market representation: Demand (discrete or large market) is marginal willingness to pay. Supply is marginal willingness to accept (cost). At  $P < P^*$  we have demand side rationing; F constitutes the higgling and bargaining set invaded by buyers and sellers omitted at P.

# Design for dynamic convergence: PMI vs WH or E

Price

P



Foregone surplus,  $F$ , is not changed via an increase in the piece-constant demand (supply),  $Q_d$  to  $Q_d'$  ( $Q_s$  to  $Q_s'$ ).  $F$  is claimed uncorrelated with changes in  $E$  &  $e$ .

**Addendum on Wealth (Assets):  
Introducing an Asset, or Saving, as  
an alternative to the Consumption  
of all current output.**

**How to model assets; i.e., savings—classical style?**

**Adam Smith defined a way, in his first book,  
*The Theory of Moral Sentiments* (1759).**

**The security motivation for saving is a direct corollary of a fundamental asymmetry between potential gain vs potential loss (rediscovered by K-T): “We suffer more...when we fall from a better to a worse situation, than we ever enjoy when we rise from a worse to a better. Security, therefore, is the first and the principal object of prudence. It is averse to expose our health, our fortune, our rank, or reputation, to any sort of hazard.” (Smith, 1759, p 213; also see p 45)**

**Consequently, imagine a WTP ‘security’ demand for savings, even if interest is zero. To save there must exist an asset,  $X$  representing stored goods (corn stored), in addition to a flow consumption good,  $x$  (corn eaten). For GE, must at minimum have units of one good, one asset,  $(x, X)$  prices  $(p, P)$ . Suppose we have  $wtp'(x)$  and  $WTP'(X)$  demands;  $wta'(x')$ ,  $x'$  = produced corn supply, with wealth constraint:**

$$PX = PX_0 + I - px; \text{ or } X = X_0 + (I/P) - x p/P; \text{ with } I/P = x' = \text{output}$$



# Asset Supply and Demand

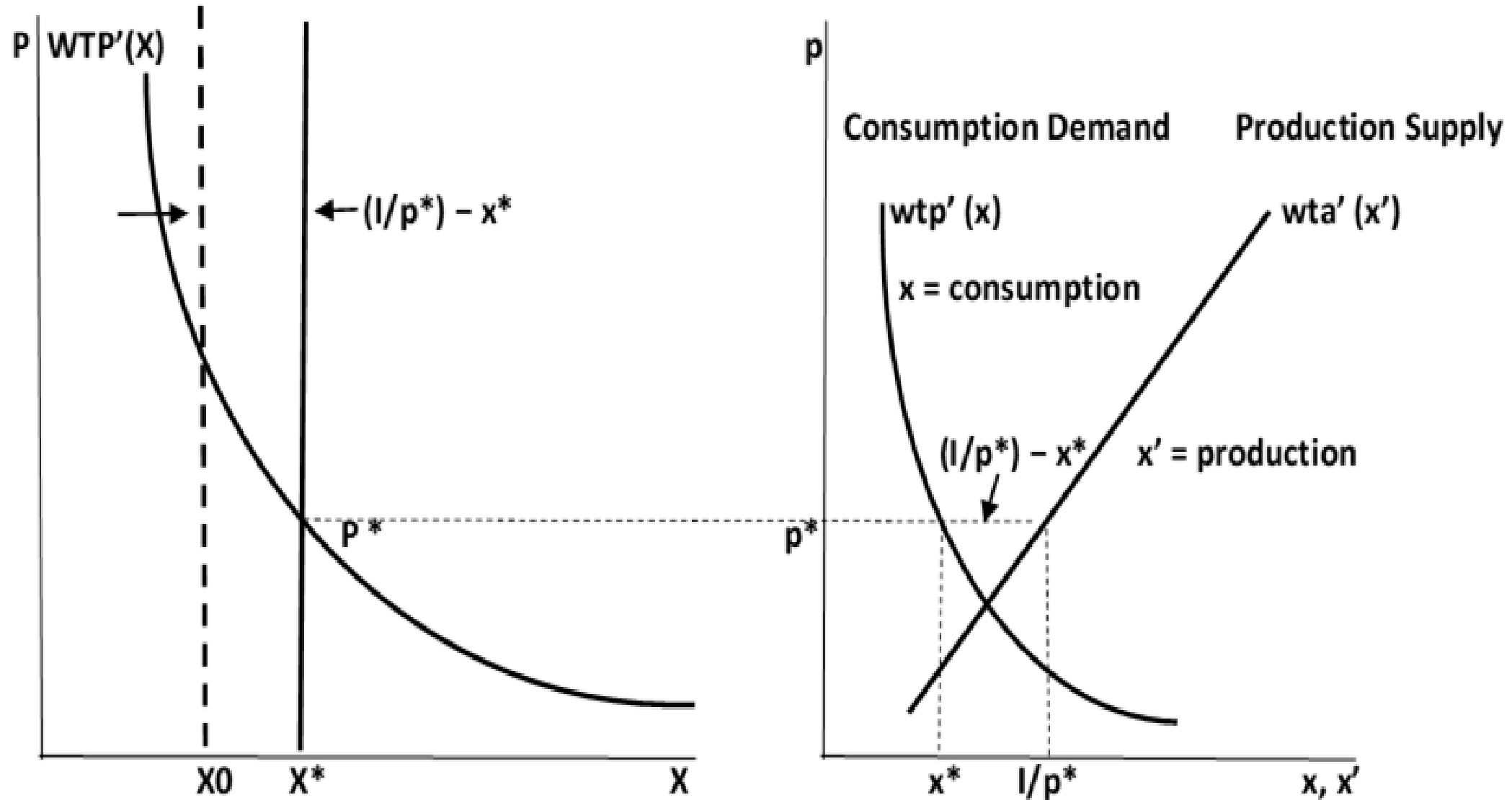


Figure 1 Supply and Demand in Asset and Commodity Markets

# **SUMMARY: REDISCOVERING CLASSICAL ECONOMICS**

**(1) Jevons/Walras: Theory of quantity choice, based on marginal utility (MU), given exogenous prices/incomes. Markets rational iff individuals are rational, via MU.**

**Price discovery requires complete information (Jevons); or imagined external agent (Walras)**

**Marshall/Menger/Bohm-Bawerk describe price discovery via WTP (WTA), *but promote MU!***

**(2) Experimental economics: Naïve, privately informed Ss easily find equilibrium, via principles of classical theory, not, as believed, via neoclassical theory.**

**(3) Classical theory:**

**Max WTP (Min WTA) for discrete units, or reservation values as functionally dependent on quantities.**

**Given quantities offered to market; “higgling and bargaining” → prices become independent variables in determining buyer and seller profit (surplus); and  $V(P)$  to be minimized.**

**Short-side rationing assures that disequilibrium foregone profit will be invaded by price adjustments causing realized profit eventually to be maximized.**

**(4) Slighted, but central to Classical Economics, is Smith (1759) *Theory of Moral Sentiments*.**

**THANK YOU**