

Inventory Control Involving Opaque Selling

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Opaque Selling

- Normal Market

Yellow T-shirt: \$9.99

Pink T-shirt: \$9.99

- Opaque Good (O-good)

Yellow T-shirt: \$9.99

Pink T-shirt: \$9.99

Random T-shirt: **\$8.99**

Lower price for customers

Seller decides what to deliver



Opaque Selling: Example

“Random Color” Product On Tmall.com



Choose Color: ¥248.00

Random Color: ¥216.00
(12.9% off)

Opaque Selling: Example

**“Vehicle
determined
upon pick-
up” Product
On Expedia**

image from: <https://www.expedia.com>

Great Deal

Special

Compact or larger - Vehicle determined upon pick-up

- 5 Passengers
- 4 Doors
- Air Conditioning
- Automatic
- Unlimited mileage ⓘ
- Fuel info: full to full ⓘ

Customer recommendations

39% recommend
Disappointed with unexpected fees and pick-up location

[1019 ratings >](#)

Free cancellation

Lock in this price today, cancel free of charge up to 6 hours before pick-up to get 100% refund.

Great deal

This car is \$62 cheaper than the average car in Special category on our website.

Great Deal

Compact

Nissan Versa or similar

- 5 Passengers
- 4 Doors
- Air Conditioning
- Automatic
- Unlimited mileage ⓘ
- Fuel info: full to full ⓘ

Customer recommendations

39% recommend
Disappointed with unexpected fees and pick-up location

[1019 ratings >](#)

Free cancellation

Lock in this price today, cancel free of charge up to 6 hours before pick-up to get 100% refund.

Great deal

This car is \$67 cheaper than the average car in Compact category on our website.

Midsize SUV

Jeep Cherokee or similar

- 5 Passengers
- 5 Doors
- Air Conditioning
- Automatic
- Unlimited mileage ⓘ
- Fuel info: full to full ⓘ

Customer recommendations

39% recommend
Disappointed with unexpected fees and pick-up location

[1019 ratings >](#)

Free cancellation

Lock in this price today, cancel free of charge up to 6 hours before pick-up to get 100% refund.

Car rental location

Pick-up & Drop-off

- Tue, Feb 28, 10:30am - Fri, Mar 3, 10:30am
- MCO Airport

\$93 total

\$102 total

\$96 total

Continue

Continue

Continue

(6.1% off)

Opaque Selling: Example

Sometimes you need it ...



France
2012
\$16.99



Spain
2013
\$18.49



Italy
2013
\$15.99



Argentina
2016
\$18.99



But,
Any Difference?

Opaque Selling: Example

“Premium Mixed” or “Blind Tasting Kit” product



France
2012
\$16.99



Spain
2013
\$18.49



Italy
2013
\$15.99



Argentina
2016
\$18.99



Premium Mixed Six
Retail Price > \$30
Total Price ≈ \$280
\$80
(71.4% off)

Why Opaque?

“Hmmm... It sounds interesting and attractive, but ... ”

Is it beneficial?

How does O-good help business?

How to ration products for O-good?

Pricing Strategy? Inventory Strategy?

Will customers accept this?

We have done some modeling work ...

- How does the seller operate opaque products?
 - Balance-inducing rationing/production/pricing
- What is the mechanism behind opaque selling?
 - Equilibrium between the strategic seller and strategic buyers
- Why does the seller want opaque selling?
 - Promotes inventory balancedness
 - Benefits both the seller and buyers
- Any new insights?
 - The sum v.s. the difference of inventory

Model Setup: Symmetry

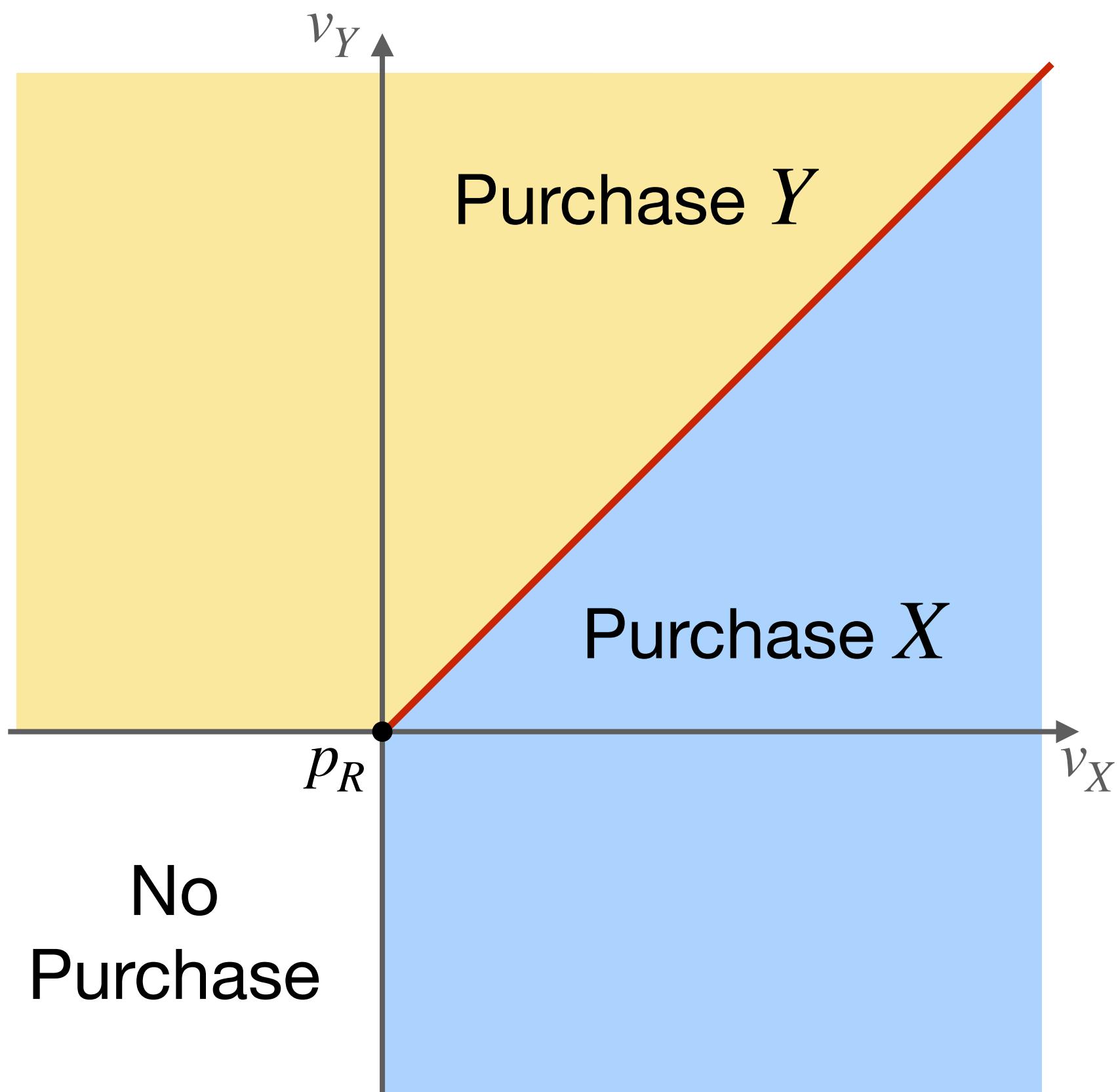
Only one seller, who sells two similar regular products, X - and Y -good, to a continuum of buyers.

E.g. different color, and with the same

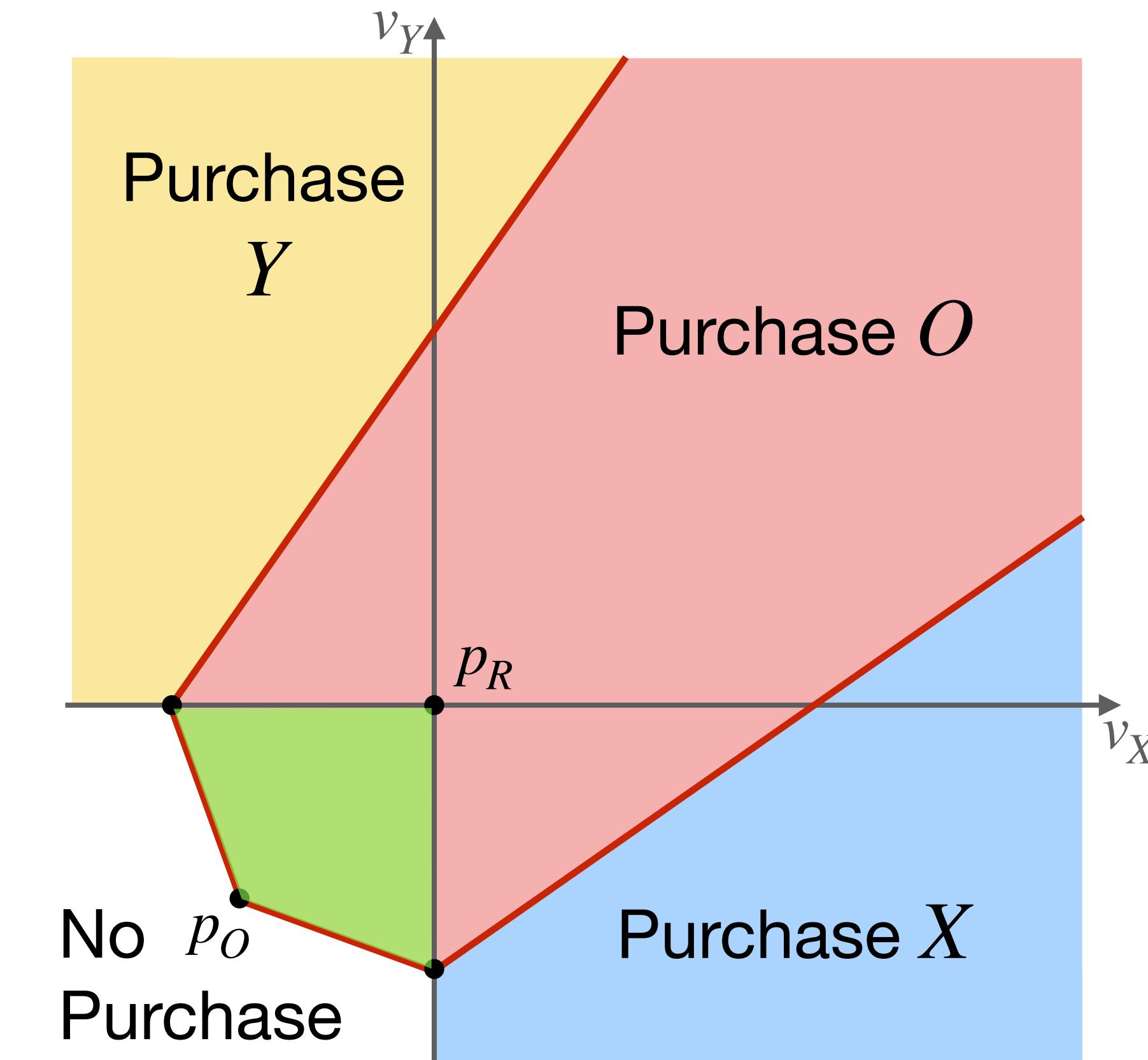
- Selling price:
regular price p_R , opaque price p_O
- Cost
- Poisson arrival rate
- Ordering or produce together



Strategic Buyer: Aggregated Behavior



Without O -good



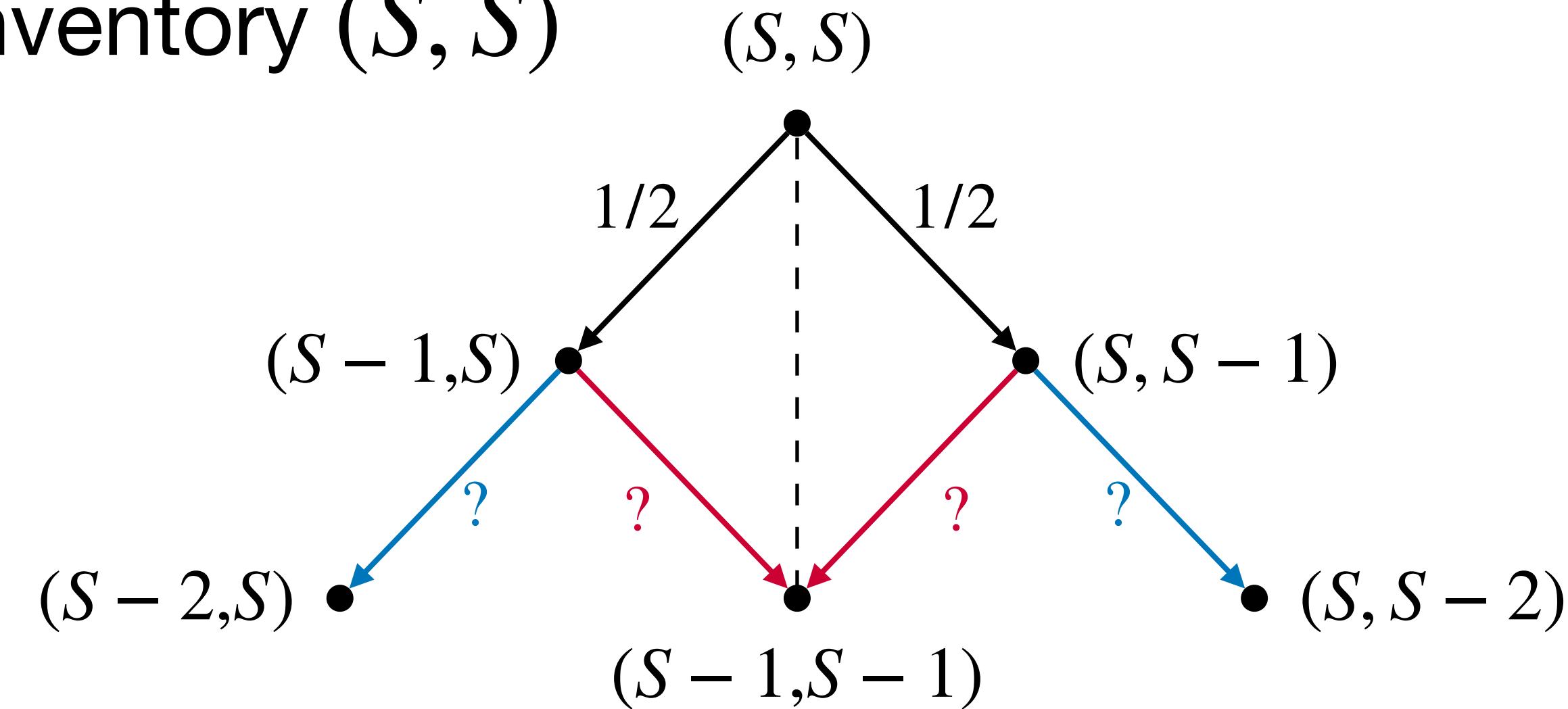
With O -good

O -good May Be Harmful for Seller!

Seller's Optimal Policy: Balance-inducing

An arriving Customer may purchases X - and Y -, O -good, or nothing

Starts from the full inventory (S, S)



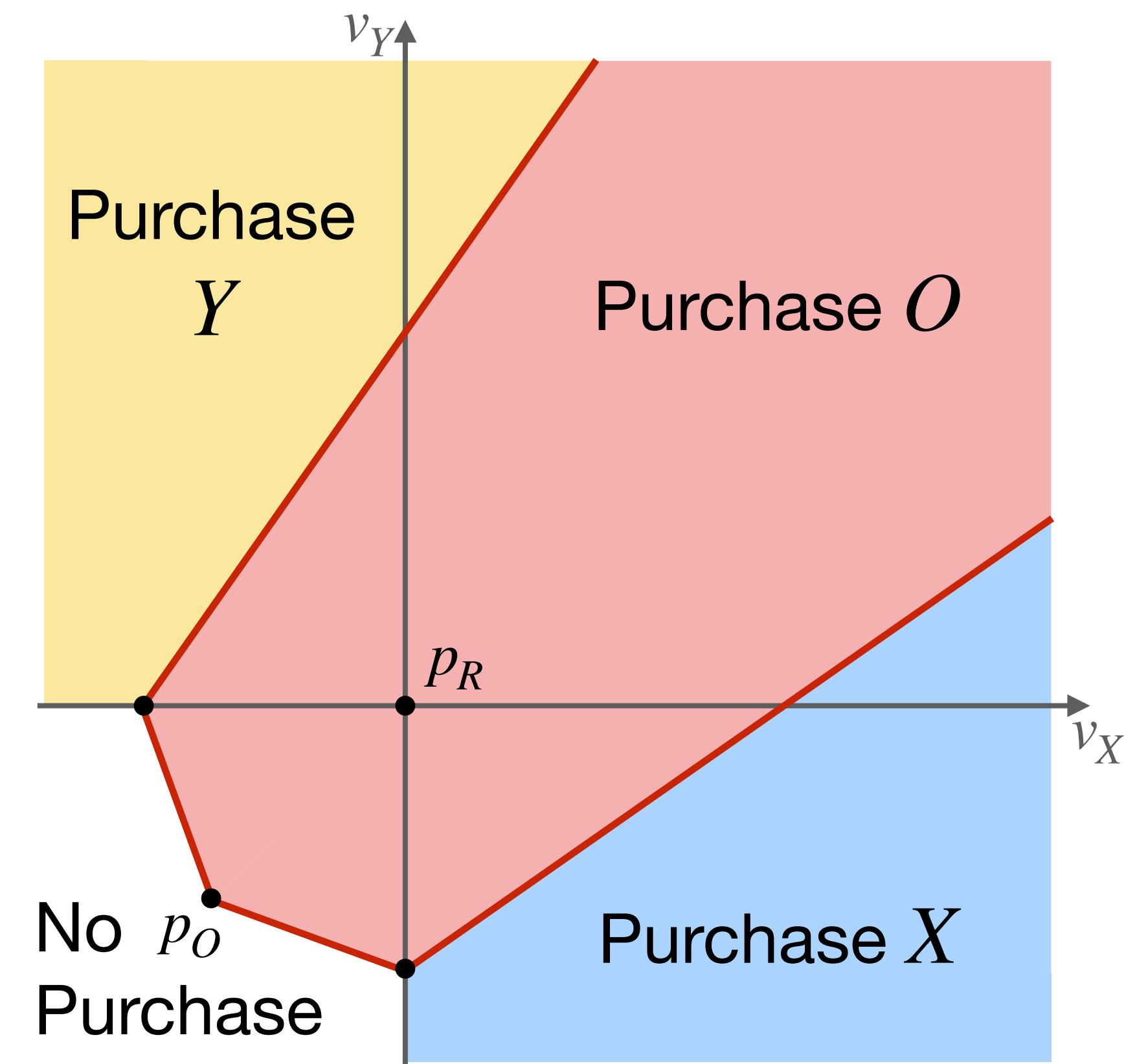
Rationing: Always give out the product with higher inventory

Balance

Under the optimal rationing strategy, we will have ...

Consider the **balance inducing power** ζ

$$\zeta = \frac{\text{Red Area}}{\text{Blue Area}} \geq 0$$



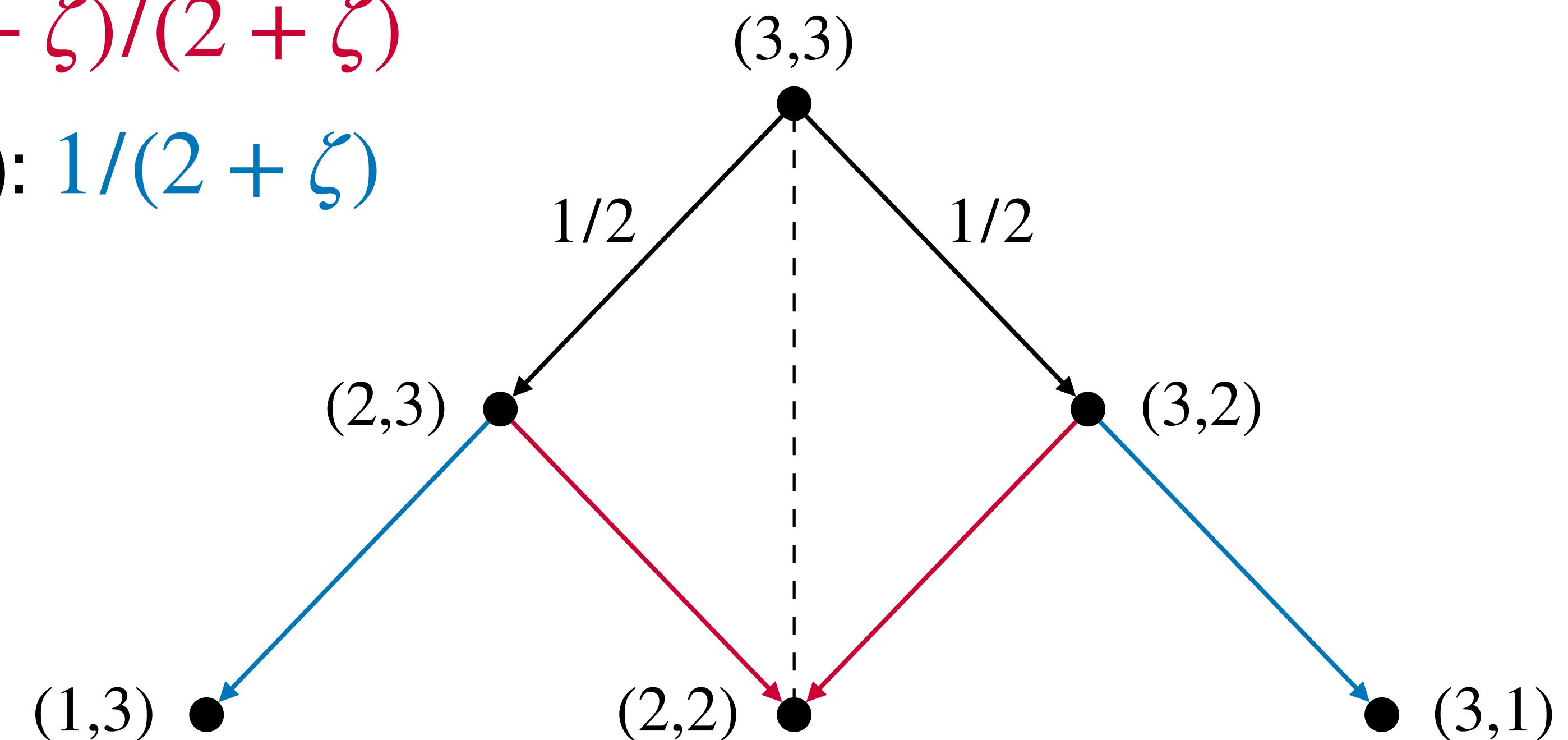
Balance

Under the optimal rationing strategy, we will have ...

Consider the **balance inducing power** $\zeta > 0$

- Going to mid (balance): $(1 + \zeta)/(2 + \zeta)$
- Going to margin (imbalance): $1/(2 + \zeta)$

But, what if we are running out
one product ...



Balance & Out-of-Stock

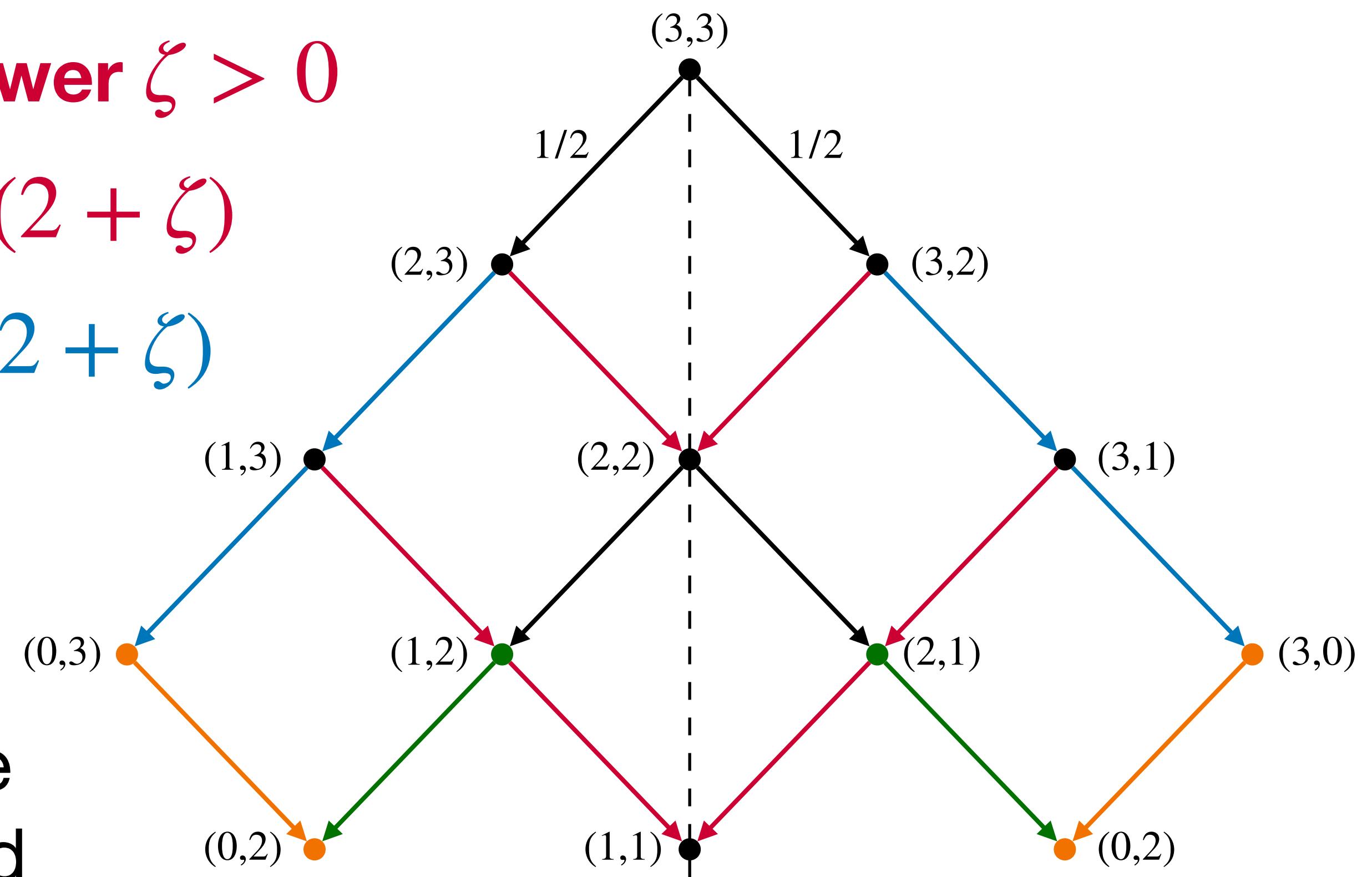
Under the optimal rationing strategy, we will have ...

Consider the **balance inducing power** $\zeta > 0$

- Going to mid (balance): $(1 + \zeta)/(2 + \zeta)$
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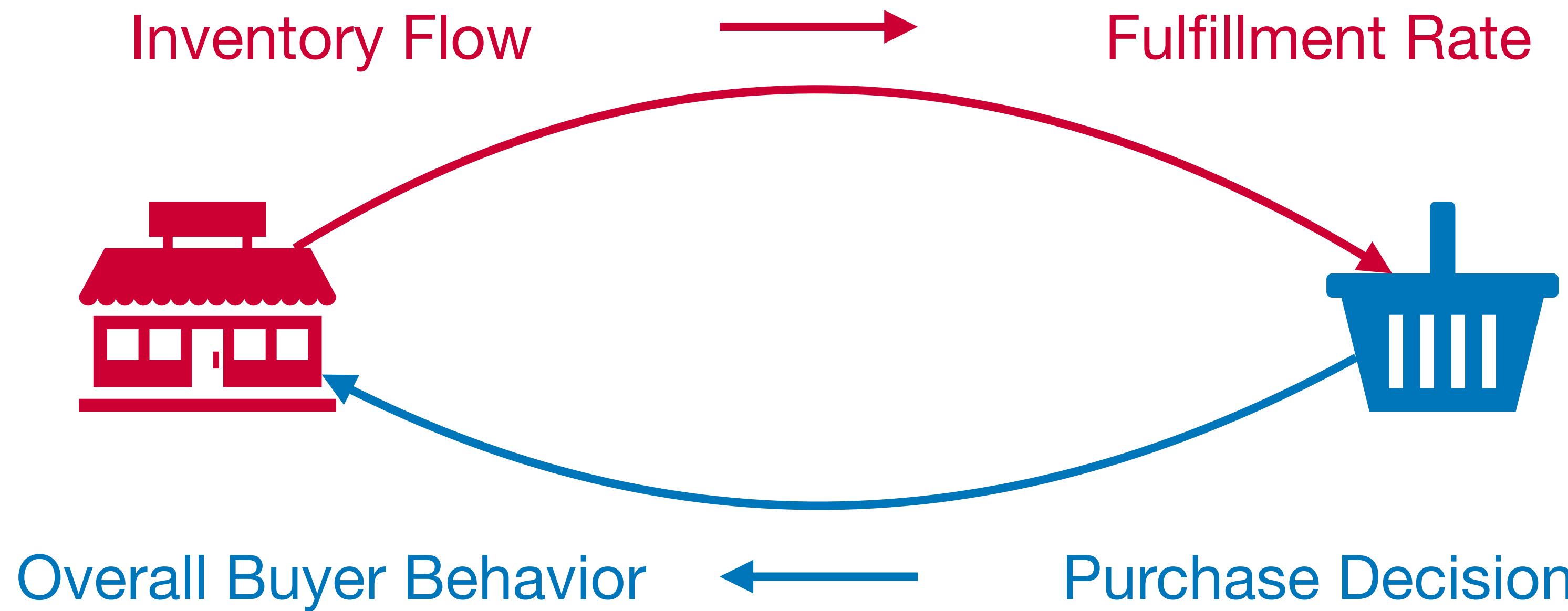
But, what if we are running out
one product ...

The Fulfillment Rate θ : The chance
that an regular request to be granted



Behind Opaque Selling: Game

Under any pricing strategy (p_O, p_R) , inventory strategy S , and buyer valuation distribution

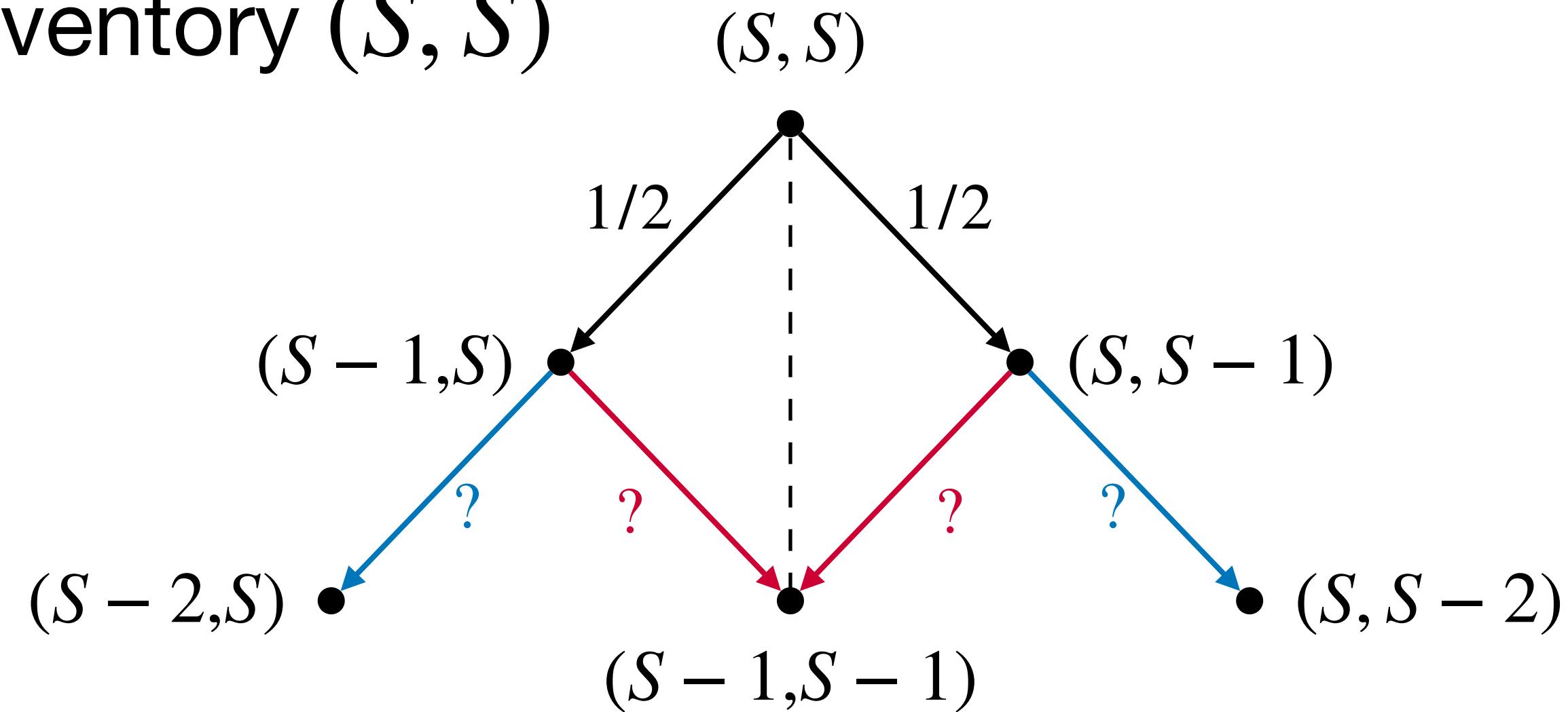


Equilibrium can be found, and will monotonically shift when the opaque price p_O or the customers' risk attitude changes

Seller's Optimal Policy: Balance-inducing

An arriving Customer may purchases X - and Y -, O -good, or nothing

Starts from the full inventory (S, S)



Rationing: Always give out the product with higher inventory

Pricing: More balanced inventory leads to higher opaque price

Production: Don't produce the product with higher inventory

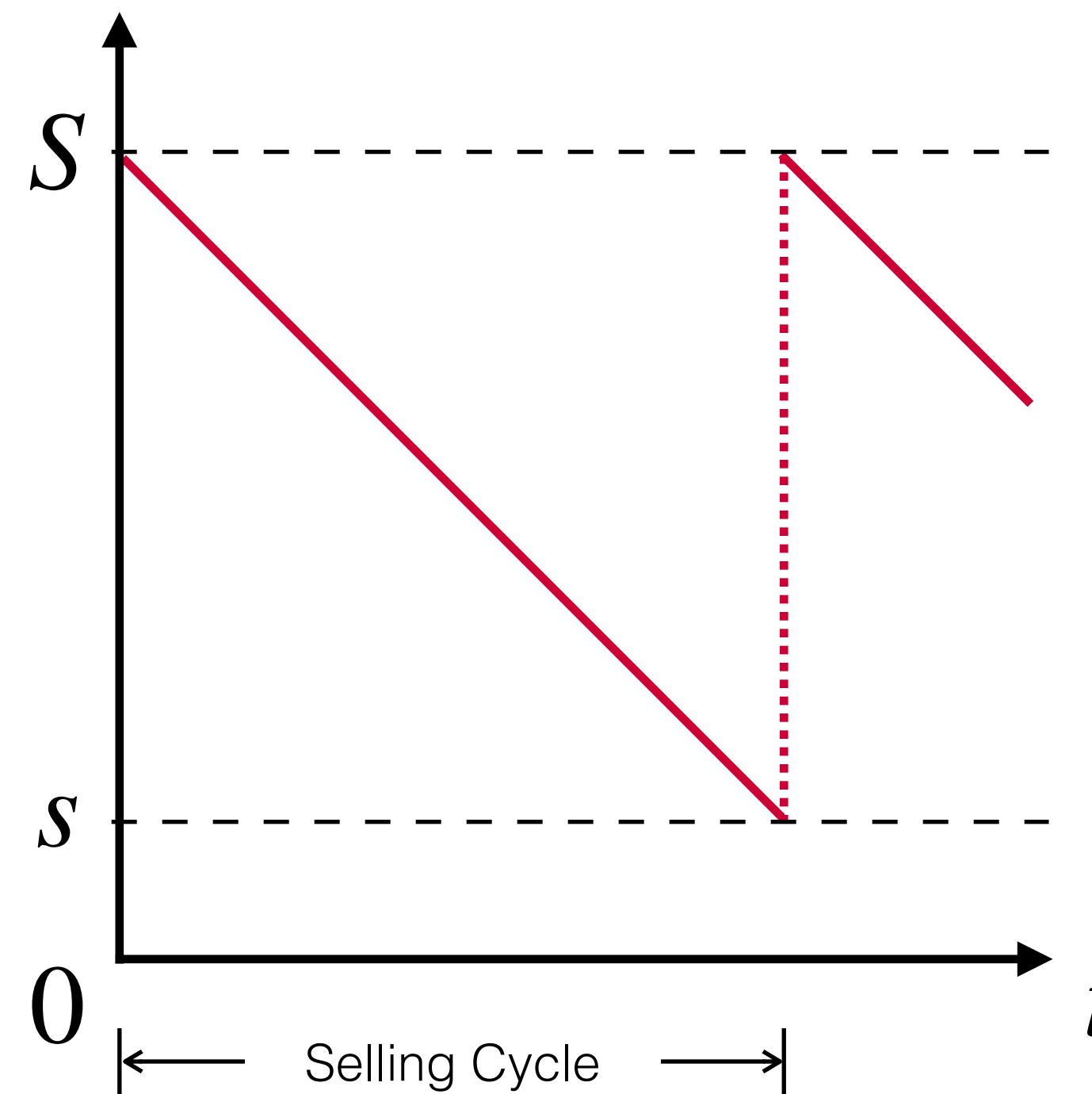
Opaque Benefits

- For the seller:
 - Attractive promotion
 - More balanced inventory
 - Higher long-run profit
 - Opaque troubles disappear when opaque price is large
- For buyers:
 - A new option never hurts
 - Bring benefit for a certain portion of customer

Opaque selling benefits both parties!

Inventory Control Insights

Traditional (s, S) policy



The **SUM** matters

Opaque Selling



The **DIFFERENCE** matters

But ...

- No model is perfect
 - Too many assumptions, but still can't cover all aspects
- The real opaque selling problem is more complicated
 - Multi-product, with unknown demand
 - Complicated customer evaluation process
 - Other marketing strategies combined with opaque selling
 - ...
- Besides parameter-based simulation, what can we do?

Example: Pop Mart

- A blind box of collectable “designer” toys
 - Every box contains one “random” toy
 - In each series, only a small portion of toys is “special”, with high collective value
 - The others are normal toys, with low collective value
 - You may get repeated toys, or a non-repeated set
 - Secondary market is available



Opaque? Gambling? Customer's Behavior? ...

Example: Styling Box

- A box of clothes mailed to you periodically
 - Get new clothes instead of shopping by yourself
 - Every box contains K items
 - Keep what you want, return everything else back
 - If you keep more items, a better discount will be applied
 - Free shipping, free return
 - No subscription needed

Opaque? Subscription Box? Top K Recommendation?

User Profile? Inventory? ...

Future Work: Data-driven Decision Making

- Some tasks are typical “AI in marketing” topics
 - Customer preference prediction
 - Top K recommendation
 - Demand distribution estimation
- Some tasks are traditional decision model
 - Inventory control, opaque selling, dynamic pricing, ...
 - Expectation rationing, game theoretical analysis
- Business Insights + Applicable Algorithm Framework

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Thanks!

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