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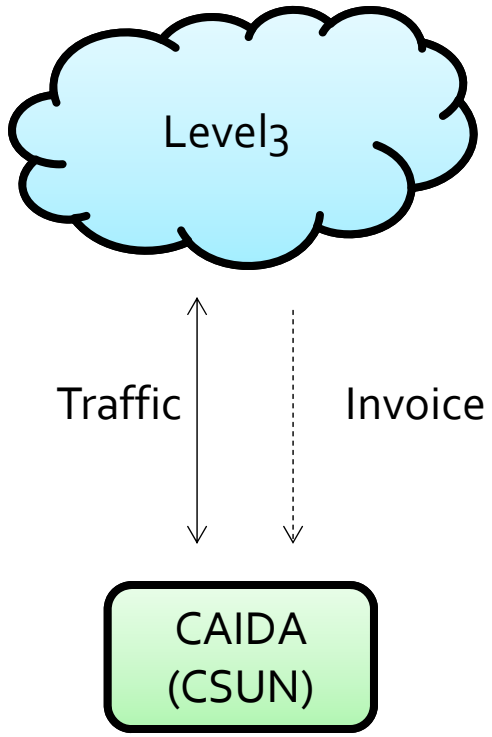
How Many Tiers? Pricing in the Internet Transit Market

Internet Transit Market

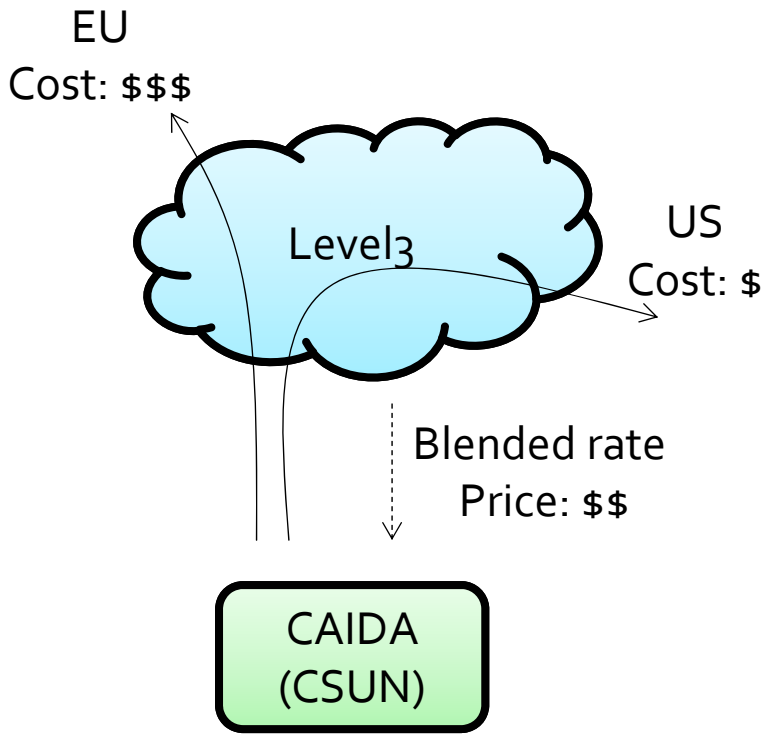
- Sellers
  - Large ISPs
  - National or international reach
- Buyers
  - Smaller ISPs
  - Enterprises
  - Content providers
  - Universities



Connectivity is sold at bulk using blended rates

What is Blended Rate Pricing?

- Single price in $/Mbps/month
- Charged each month on aggregate throughput
  - Some flows are costly
  - Some are cheaper to serve
  - Price is set to recover total costs + margin
- Convenient for ISPs and clients



Can be inefficient!

Issues With Blended Rate Pricing

Uniform price yet diverse resource costs

Clients

Lack of incentives to conserve resources to costly destinations

ISPs

Lack of incentives to invest in resources to costly destinations

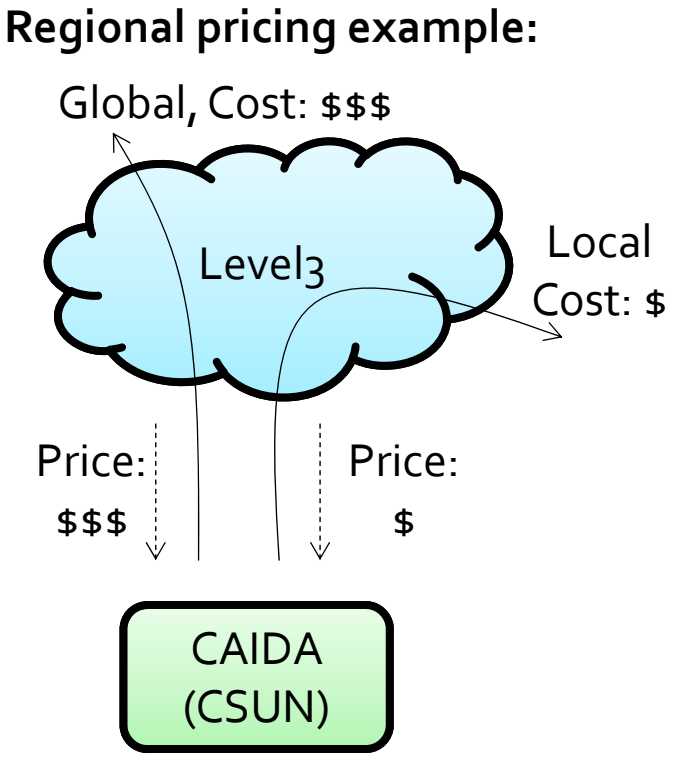
- **Pareto inefficient resource allocation**
  - A well studied concept in economics
- Potential loss to ISP profit and client surplus

Alternative: Tiered Pricing

Tiered Pricing

Price flows based on cost and demand

- Some ISPs already use tiered pricing
  - Regional pricing
  - Paid peering
  - Backplane peering
  - Limited number of tiers



Question:

How efficient is such tiered pricing?

Can ISPs benefit from more tiers?

Challenges

How can we test the effects of tiered pricing on ISP profits?

Modeling

1. Construct an ISP profit model that accounts for:
   - **Demand** of different flows
   - **Servicing costs** of different flows

Data mapping

2. Drive the model with **real data**
   - **Demand functions** from **real traffic data**
   - **Servicing costs** from **real topology data**

Number crunching

3. Test the effects of tiered pricing!

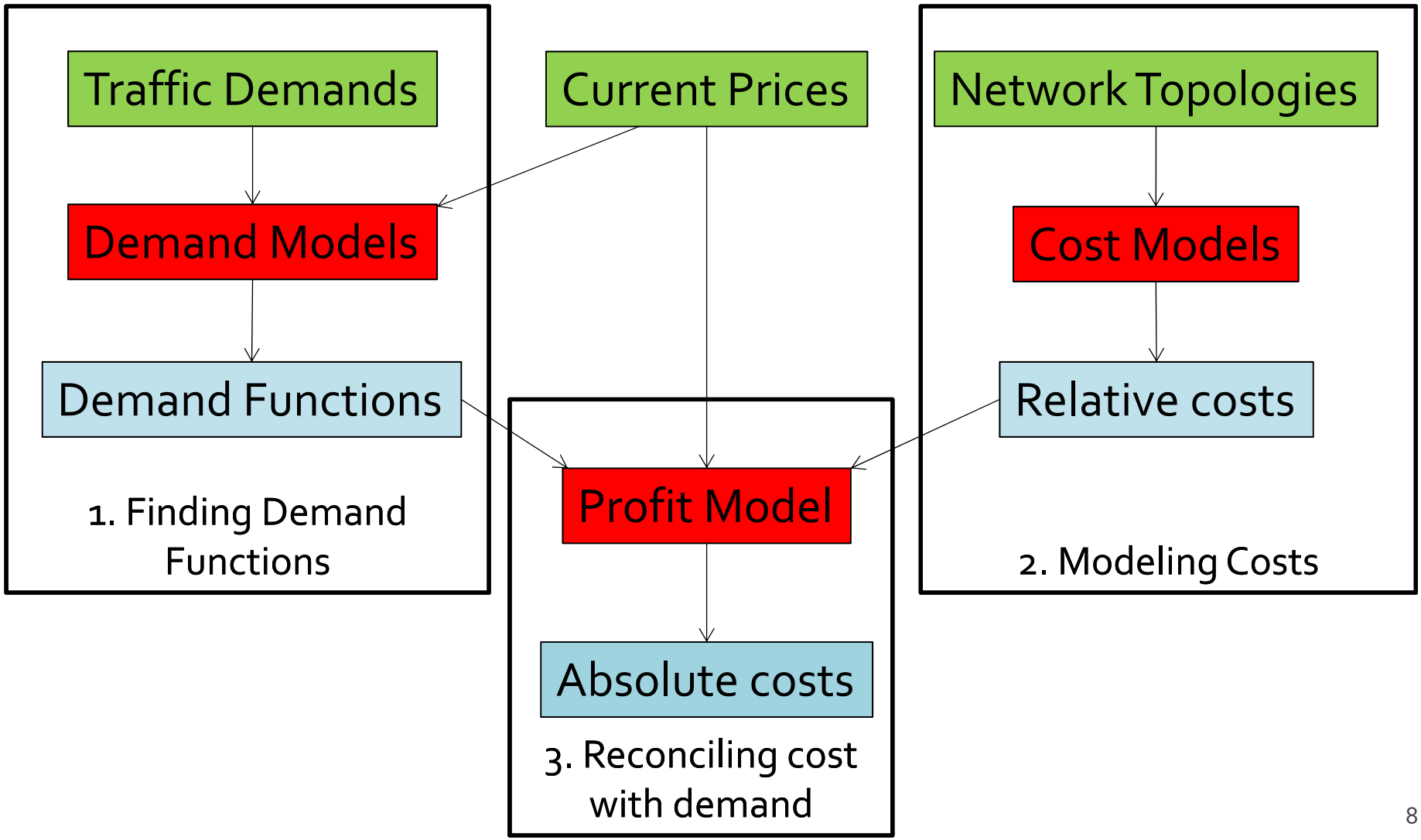
ISP Profit Model: Assumptions

Profit = Revenue – Costs
(for all flows)

- Flow revenue
  - **Price * Traffic Demand**
  - Traffic Demand is a function of price
  - How do we **model** and **discover** demand functions?

- Flow cost
  - **Servicing Cost * Traffic Demand**
  - Servicing Cost is a function of distance
  - How do we **model** and **discover** servicing costs?

Approach to Modeling

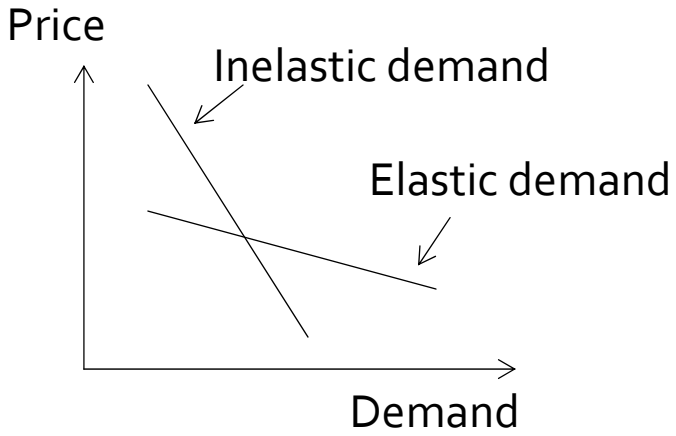


Finding Demand Functions

Canonical commodity demand function:

Demand = F(Price, Valuation, Elasticity)

Valuation – how valuable flow is
Elasticity – how fast demand changes with price



How do we find the demand function parameters?

Valuation = F^{-1}(Price, Demand, Elasticity)

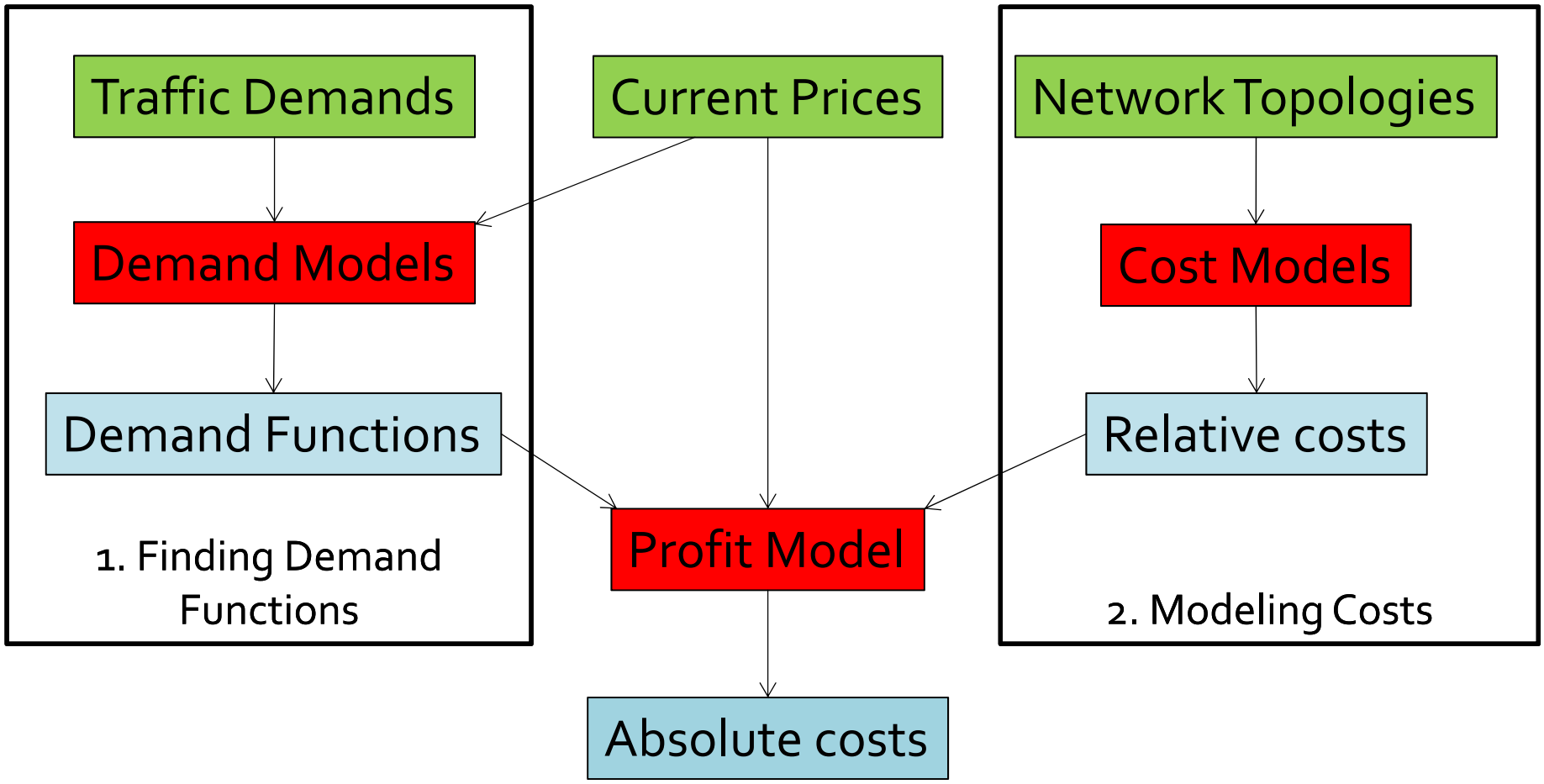
Current price

Current flow demand

Assumed range of elasticities

We mapped traffic data to demand functions!

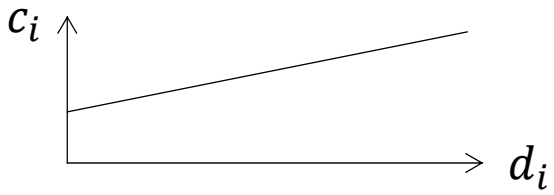
Approach to Modeling



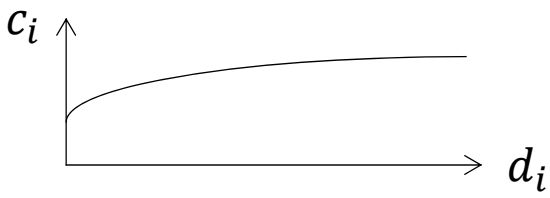
Modeling Costs

How can we model flow costs?

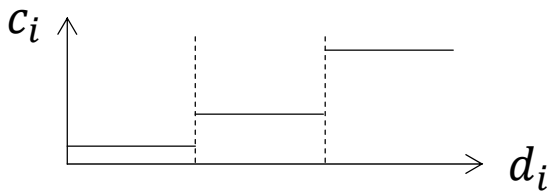
Linear:



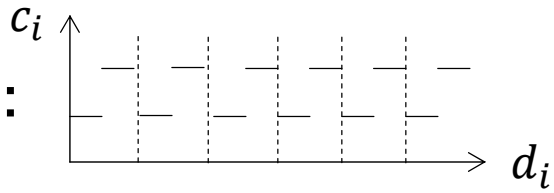
Concave:



Region:



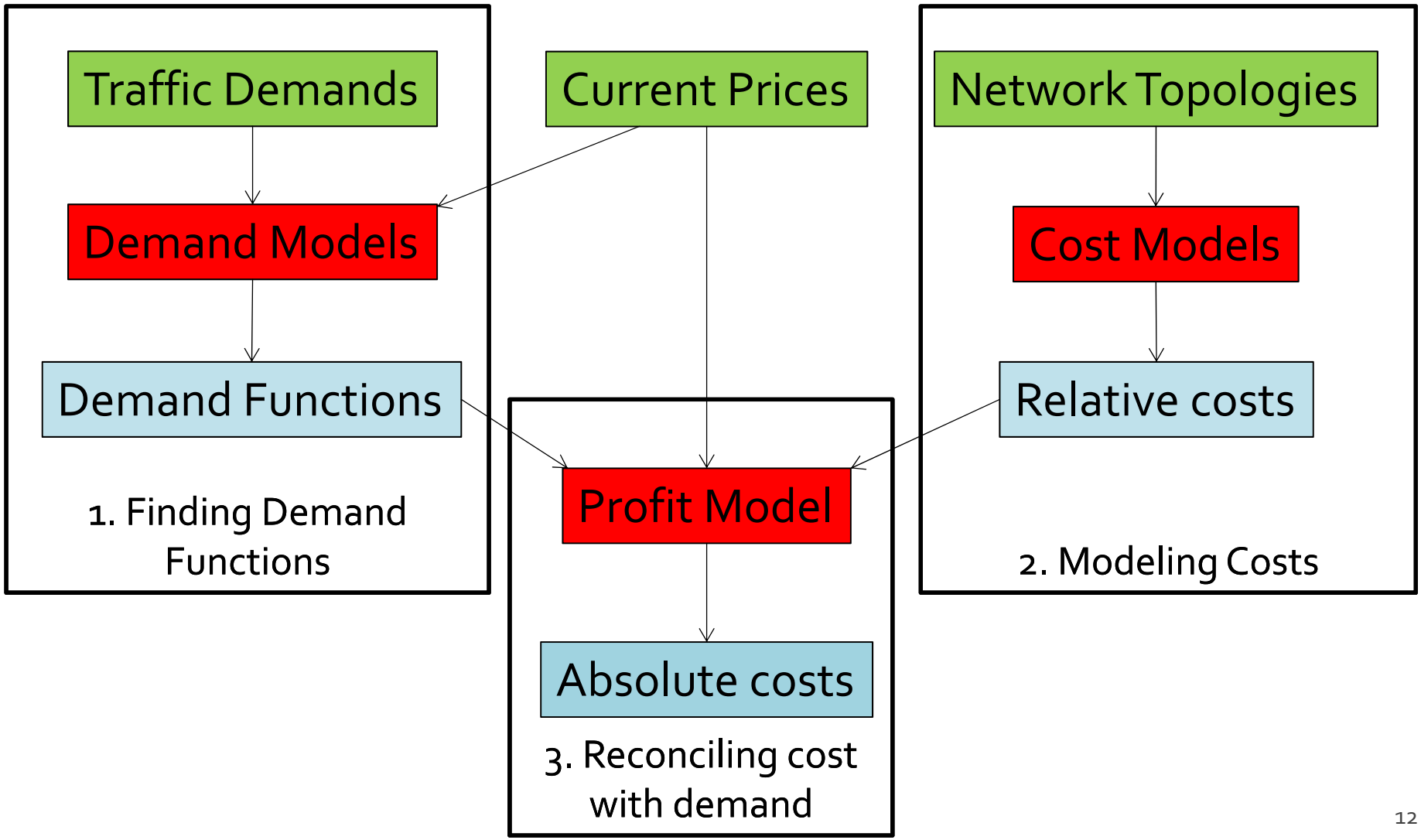
Dest. type:



ISP topologies and peering information alone
can only provide us with **relative flow servicing costs**.

real_costs = γ * relative_costs

Approach to Modeling



Normalizing Costs and Demands

Assuming ISP is rational and profit maximizing:

Profit = Revenue – Costs = F(**price**, **valuations**, **elasticities**, **real_costs**)

↓

F′(**price***, **valuations**, **elasticities**, **real_costs**) = 0

↓

F′ (**price***, **valuations**, **elasticities**, **γ** * **relative_costs**) = 0

↓

γ = F'^{-1}(**price***, **valuations**, **elasticities**, **relative_costs**)

Data mapping is complete: we know demands and costs!

Subject to the noise that is inherent in any structural estimation.

Testing ISP Pricing Strategies

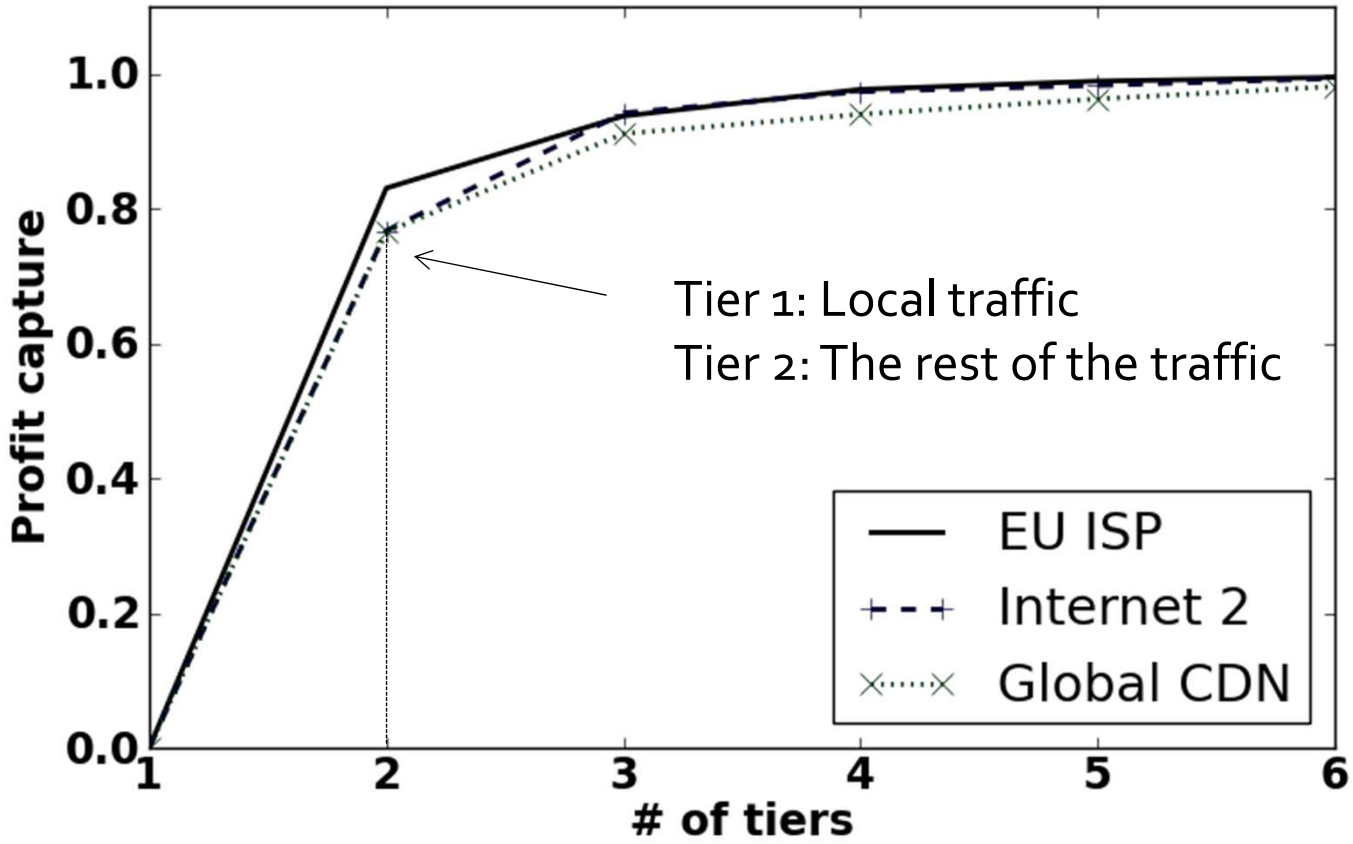
1. Select a number of pricing tiers to test
   - 1, 2, 3, etc.
2. Map flows into pricing tiers
   - Optimal mapping and mapping heuristics
3. Find profit maximizing price for each pricing tier and compute the profit

Repeat above for:

- 2x demand models
- 4x cost models
- 3x network topologies and traffic matrices

Profit Capture Results

Constant elasticity demand with **linear cost model**



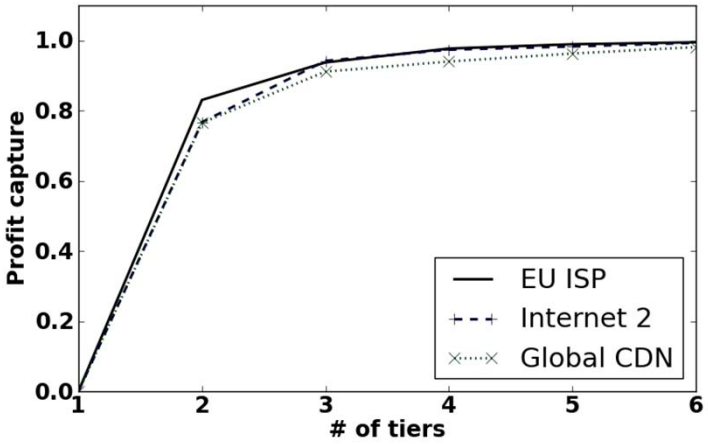
*Elasticity – 1.1, base cost – 20%, seed price - $20

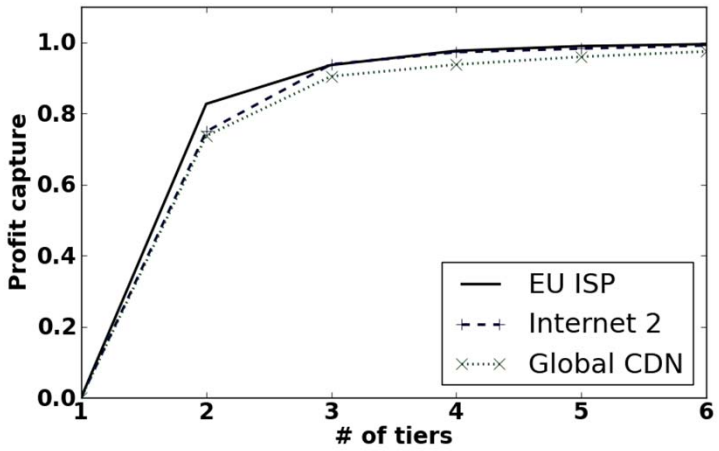
Results: Big Picture

Linear Cost Model

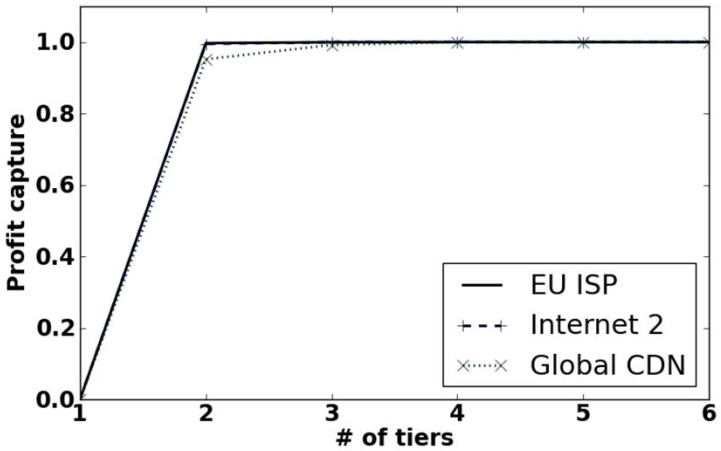
Concave Cost Model

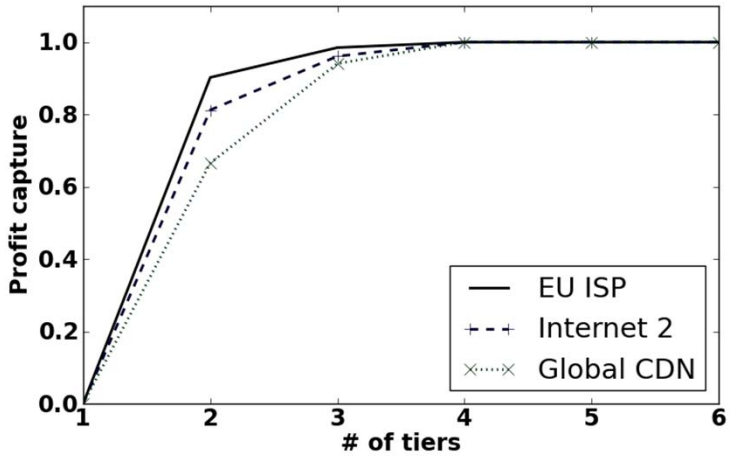
Constant Elasticity Demand





Logit Demand





Areas for Improvement

- Refine demand and cost modeling
  - Hybrid demand and cost models are likely more realistic
- Establish metrics that predict the benefit of tiered pricing based on the observed demand and cost data
- Establish conditions under which demand and cost normalization framework works
  - E.g., can we normalize cost and demand if cost is a product of the unit cost and the log of the demand?
- Test the effects of tiered pricing on surplus

Summary

- ISPs today predominantly use blended rate pricing
- Our study shows that having more than 2-3 pricing tiers adds only marginal benefit to the ISP
- The results hold for wide range of scenarios
  - Different demand and cost models
  - Different network topologies and demands
  - Large range of input parameters
- The methods of finding demands and reconciling them with cost models might find uses outside profit analysis

Questions?

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