Ad-platform Competition with Endogenous Bilateral Multi-homing

Simon P. Anderson (UVA)
Oystein Foros and Hans Jarle Kind (NHH, Bergen)

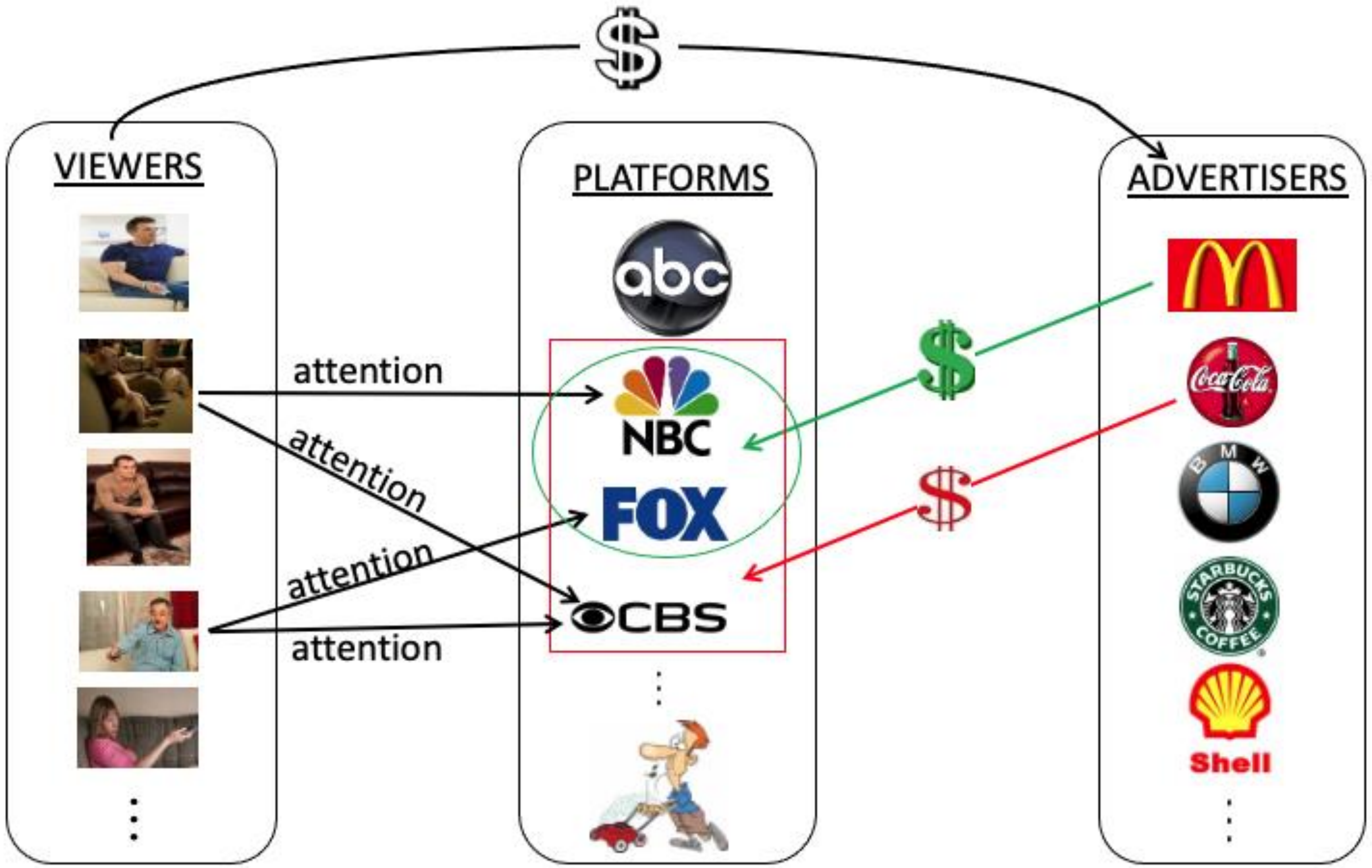
21CRETE23
July 10-14 2023

2-Sided ad-financed Markets

- Two-sides
  - Advertisers (like viewers)
  - viewers (dislike ads)

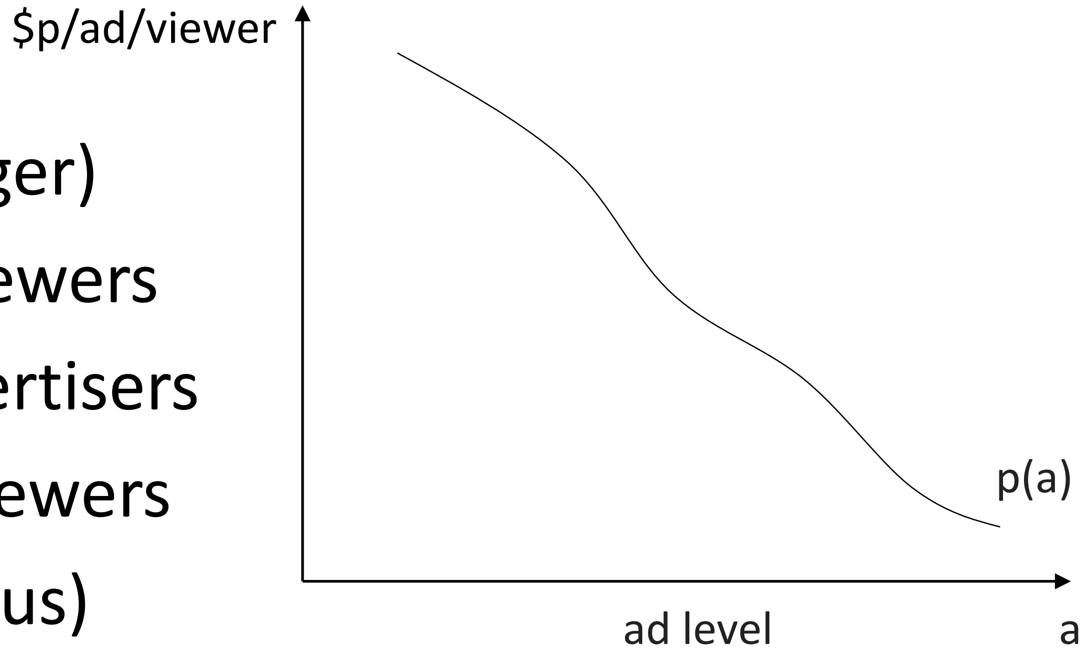
- Platforms choose ad-level; mediate sides

- Unlike 'night-club' models *single* price (ad-level) set



Ad-level determines 'price' on both sides!

A change (exit, merger)
causes ↑price to viewers
then ↓price to advertisers
(but ↓number of viewers
so $P/ad is ambiguous)

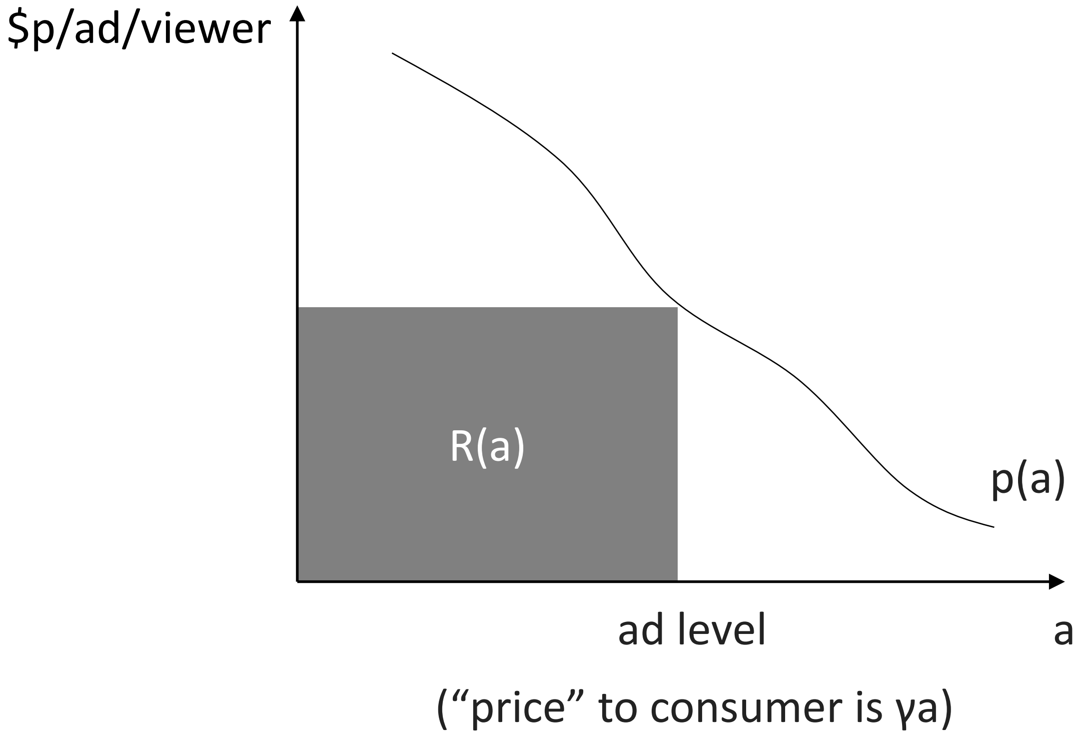


("price" to consumer is γa)

Hence "see-saw" effects

(NB: independent advertisers and viewer tastes)

Thence find revenue per viewer, R(a):



and then solve platform problem

Platform Profit Maximization

- Platform profit: $\max_a \pi = P(a)a = p(a)N(a)a = R(a)N(a)$
  - P(a): \$/ad
  - p(a): \$/viewer/ad
- Hence "two-sided market balance" eq: $R'/R = -N'/N$
  - In oligopoly: $\downarrow$ ads with more firms, $\uparrow$ price per ad per viewer

- Ad levels **BELOW** "monopoly" level $R'=0$!

"Single-Homing" Viewers
(so advertisers "multi-home")
(early models)

- "Competitive" (monopoly) bottleneck
  - Platforms compete for unique eyeballs

- Some "paradoxes"
  - Entry ↓ ad level so ↑ \$p/ad/viewer
  - Merger ↑ ad level so ↓ \$/ad/viewer
  - Private broadcasters want Public to carry ads

Introduce “**multi-homing**” (MH)

- Introduces direct competition for advertisers
- Simplest version – homogeneous advertisers
    - Can relax paradoxes (Entry ↓ \$P/ad; Merger ↑ \$P/ad …)

- How to model multi-homing?

Viewer preferences over bundles of programmes

Heterogeneous advertisers wtp for “buckets” of viewers

- This is where we are! Endogenous bilateral multihoming

Also investigating: choosing P and (rationally) anticipating ads

Research questions [and answers!]

- (when) can we have "classic" SHV? And MHA

[high enough ad nuisance costs; monopoly ad levels]

- (when) can we have FMHV? And what do advertisers do?

[low ad nuisance costs; ad price ->0]

- (when) can we have what other patterns?

[1 asymmetric eq with PSHV and PMHA]

What are efficiency properties of asym eq?

- Highest wtp advertisers on both
- Smaller next tranche on larger platform only
- More advertisers on smaller (and less profitable!) platform

- So smaller audience for “most&worst” ads
- Efficient matching through market equilibrium? Limited

Makes sure best ads are seen by all, but next best have smaller audience – need this to get viewers

Hold-up? And unobserved ads

- Does lack of commitment on ads reduce profit?

[it *raises* profit to monopoly level in SHV case

consumers indeed worse off!

Because takes out competition for viewers]

- Is it different when MHV?

[profits go to zero as advertisers can shop around perfectly]

- How do platforms mitigate MHV?

[they can’t commit to price ads low, though they could if ads observed]

Does Multi-Homing kill platform profits?

- It depends who is MH!
- FMHV does kill profits completely
- In contrast, when all active advertisers MH we have full collusion outcome
- Higher ad nuisance cost can raise profit by reducing MHV

Antecedents / history

Athey - Scott Morton (June 22) – endogenous homing models needed

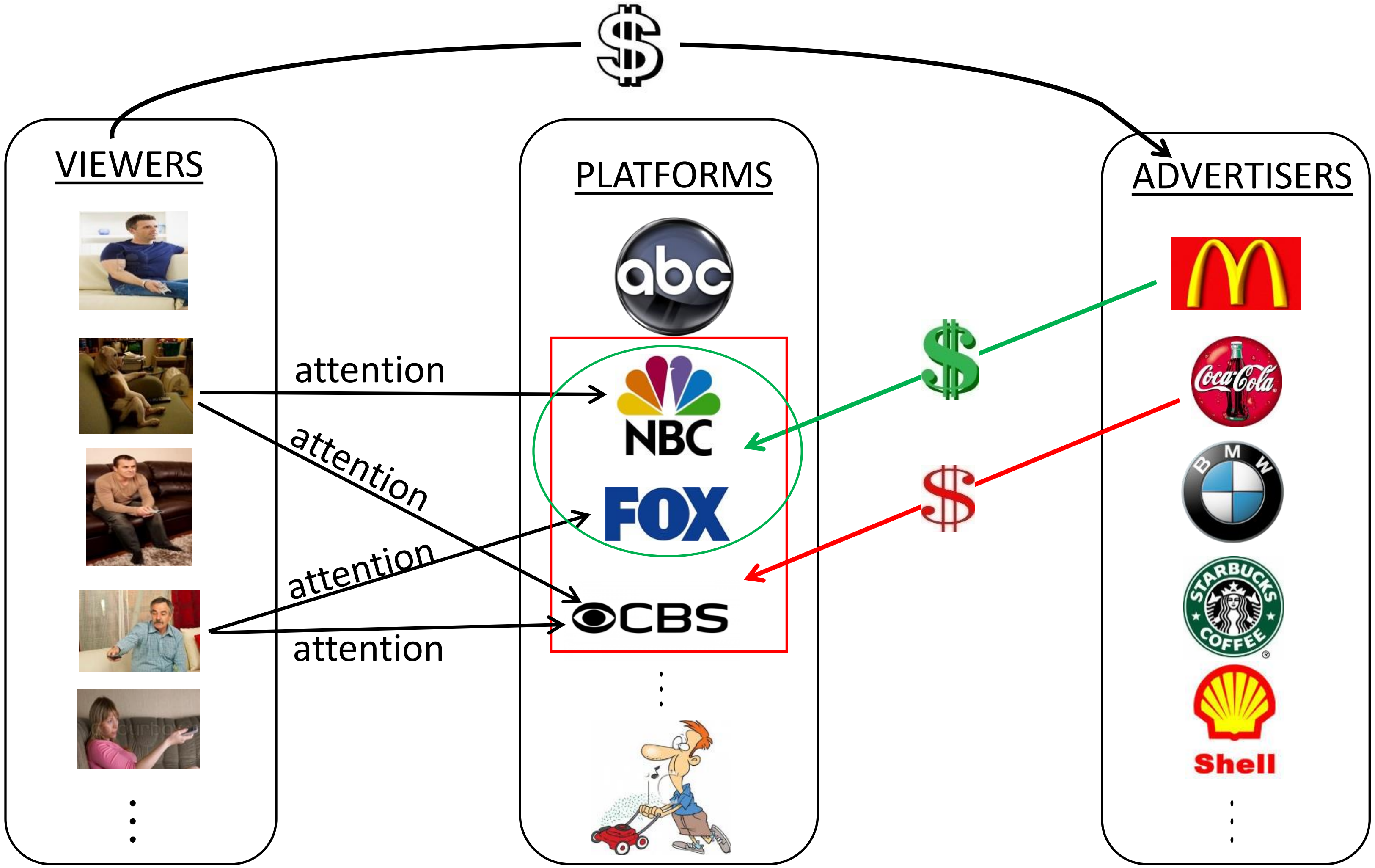
- Gentzkow-Shapiro-Yang-Yurukglu (2022):

importance of media Multi-Homing empirically

- Shi PhD16 – US magazines, exclusive readers worth twice as much

- (some earlier pointers of MH for media ecs in our earlier work & with Peitz)

2-sided business model



Why Multi-Homing (MH) Matters?

- No ‘competitive’ (monopoly) bottleneck
- Results in direct competition for advertisers

- Previous Work (EJ17 paper w/FK; also IJIO14 w/FKP)

Also Anderson-Peitz23 Information Congestion approach

Related Literature

- Gentzkow, Shapiro, Yang, Yurukoglu "Pricing power in advertising markets: Theory and evidence" NBER22
- Shi PhD UVA16 "Catching (exclusive) eyeballs: Multi-homing and platform competition in the magazine industry"
- Crampes Haritchabalet Jullien "Advertising, Competition and Entry in Media Industries" JIE09
- Ambrus Calvano Reisinger "Either or both competition: a "two-sided" theory of advertising with overlapping viewership" AEJ-Micro16
- Athey Calvano Gans "The Impact of Consumer Multi-Homing on Advertising Markets and Media Competition" Management Science 18
- Gabszewicz and Wauthy "The option of joint purchase in vertically differentiated markets" ET03
- Anderson Peitz "Ad clutter, time use, and media diversity" AEJ-Micro Forthcoming
- Anderson Peitz "Media See-saws: Winners and Losers in Platform Markets" JET20
- Anderson Foros Kind "Competition for advertisers and for consumers in media markets" EJ18
- Anderson Foros Kind "Product functionality, competition, and multi-purchasing" IER17
- Jeitschko Tremblay "Platform competition with endogenous homing" IER20
- Armstrong "Competition in two-sided markets" RAND06
- Scott Morton FM, Athey S. "Platform annexation" SSRN21
- Etc!! …

Model Constituent Building Blocks

- 2 - sided duopoly ad-financed media market
- Viewers – builds on Anderson-Foros-Kind IER17 and Kim-Serfes JIE06
  - Horizontally differentiated viewers
  - Hotelling EJ29 with **possibility** of multihoming
- Advertisers – vertical differentiation model (GT&SS)
  - Augmented for multi-homing building on Gabszewicz and Wauthy ET03
  - Vertically differentiated – some advertisers wtp more for contacts
  - No benefit for a second impression per viewer

Model Timing

Platforms set ad Prices & Viewers visit platform(s)

Advertisers see Prices and decide where/whether to place an ad

- viewers do not see ad levels (or ad prices) before deciding platform(s)
- ad levels rationally anticipated by viewers
- advertisers rationally anticipate viewer levels

- We are 3 steps away from standard Anderson-Coate RES05 model

– **Multi-homing**

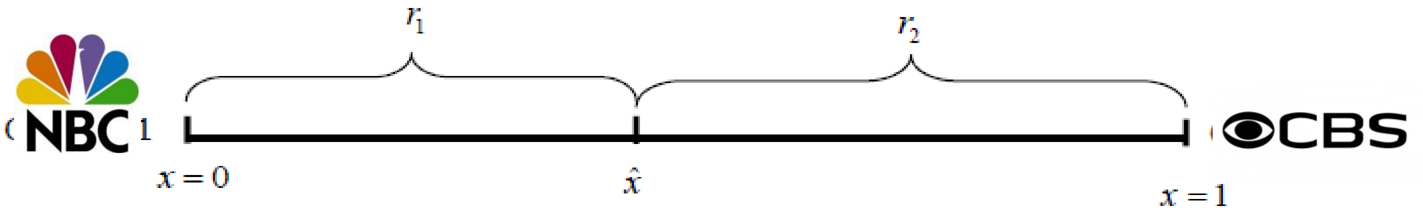
-- **Prices per ad** (also in CHJ JIE09, tho just SHV bottleneck): like Ad Rate Cards

-- Ad levels **not observed** but rationally anticipated

(don’t see ad levels before join site / finish movie)

Viewer Side: Horizontal Differentiation

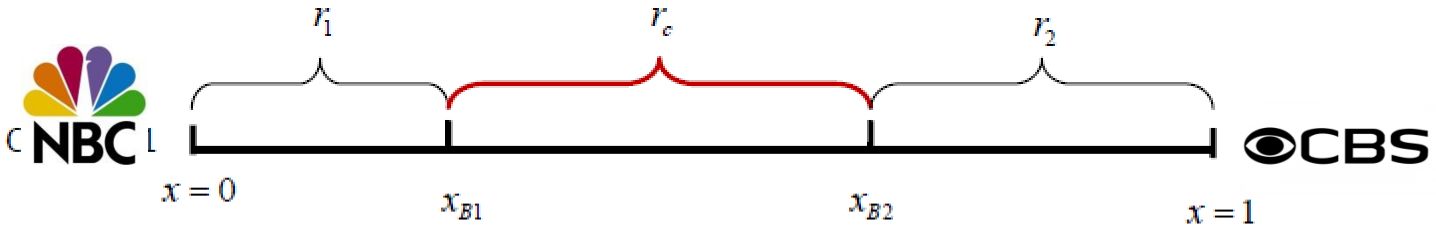
- SH Viewers (Classic Hotelling):



Utility: $U_1 = \psi - tx - \gamma a_1$

$$U_2 = \psi - t(1\text{-}x) - \gamma a_2$$

- MH Viewers:

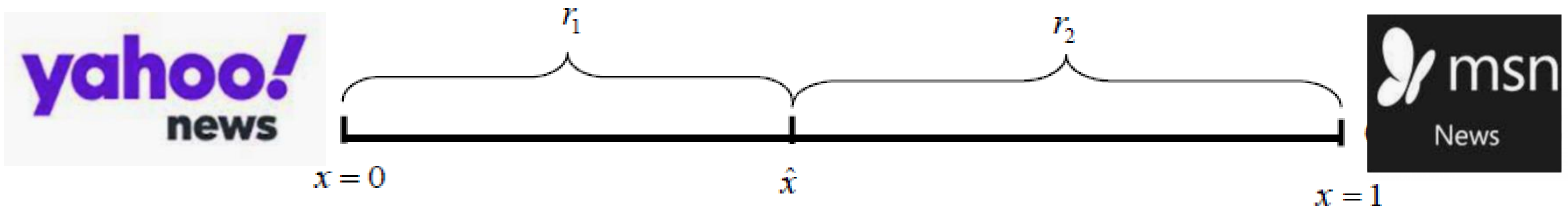


$$U_{12} = U_1 + (\psi - t(1\text{-}x))\delta - \gamma a_2$$

Incremental Value

Viewer Side: Horizontal Differentiation

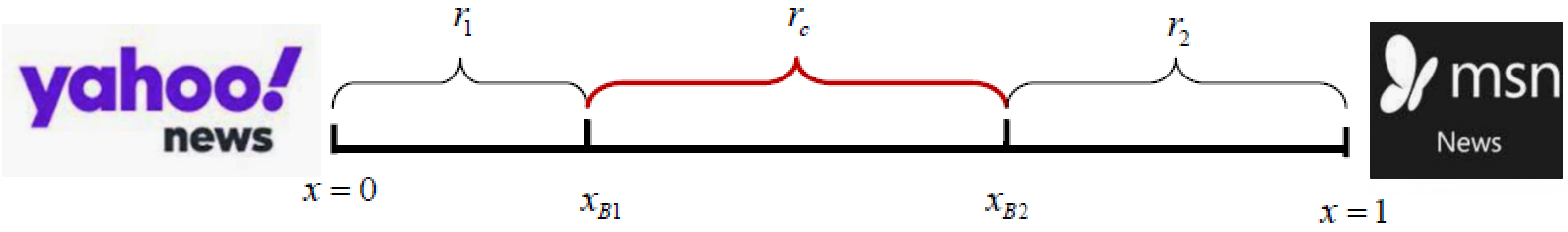
- SH Viewers (Classic Hotelling):



Utility: $U_1 = \psi - tx - \gamma a_1$

$$U_2 = \psi - t(1\text{-}x) - \gamma a_2$$

- MH Viewers:



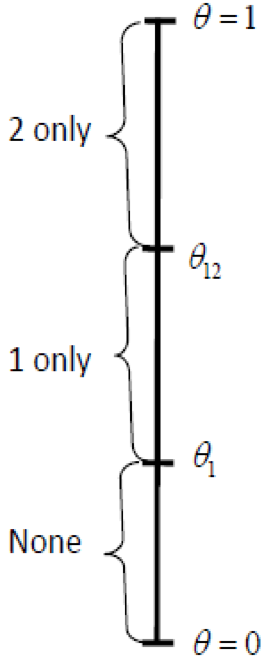
$$U_{12} = U_1 + (\psi - t(1\text{-}x))\delta - \gamma a_2$$

Incremental Value

Advertiser Side: Vertical Differentiation

- Single-Homing Advertisers (Classic VD): value

$$V_i = \theta r_i - P_i$$



- **Multi-Homing Advertisers: value**

$$V_i = \Theta(r_i + r_c) - P_i$$

$$V_B = \theta(r_1 + r_2 + r_c) - P_1 - P_2$$

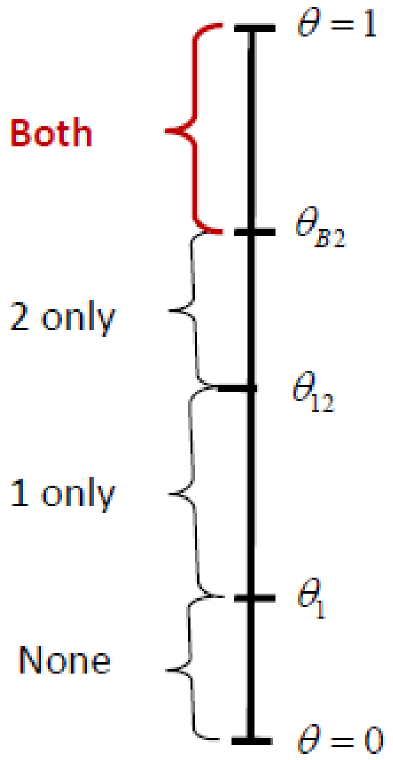
Then

$$\theta_{B2} = \frac{P_1}{r_1}$$

Incremental Value

$$\theta_{12} = \frac{P_2 - P_1}{r_2 - r_1}$$

$$\theta_1 = \frac{P_1}{r_1 + r_c}$$



Analysis – regimes

- A priori, can face many regime types
- Single/Fully/Partially Multi-Homing Viewers

  and likewise advertisers (SHA, FMHA, MHA)
- Whittle down to 2 book-end cases

  – "competitive bottleneck" (SHV – all viewers Single-Home)

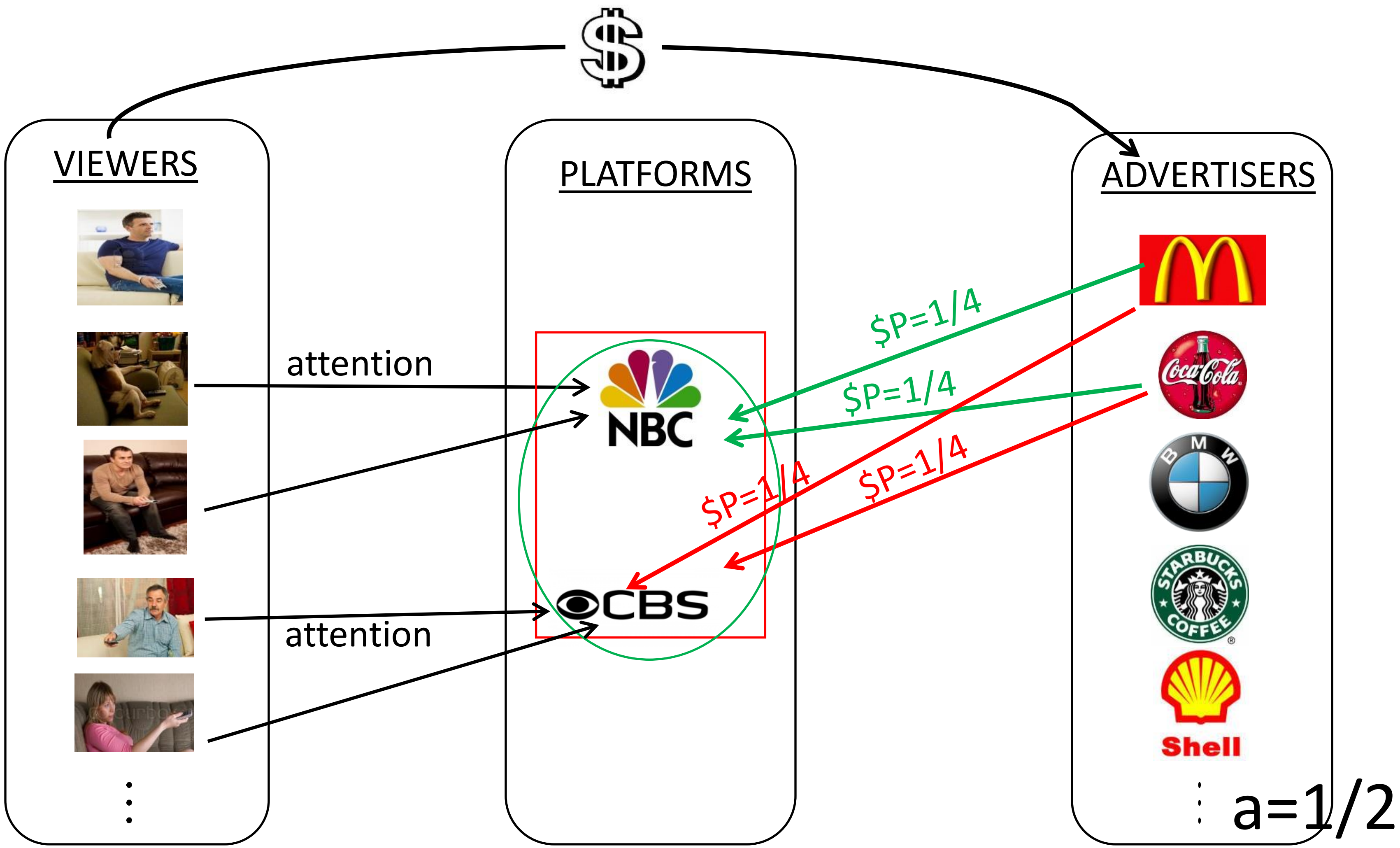
  and all active advertisers Multi-Home (MHA)

  -- "full competition"(FMHV – all viewers Multi-Home)

-- Otherwise, endogenous partial multi-homing on BOTH sides; PMHV and PMHA
with advertiser partition {B,2,1,0}
THIS is the (interesting?) case of endogenous platform asymmetry

No other regime type can exist

Book-end SHV & MHA



Book-end: Competitive Bottleneck

- If all Viewers Single-Home then Advertisers can only reach them through Viewer's exclusive channel
- Platforms charge Monopoly access fees: $P = 1/4$ per ad and $a = 1/2$

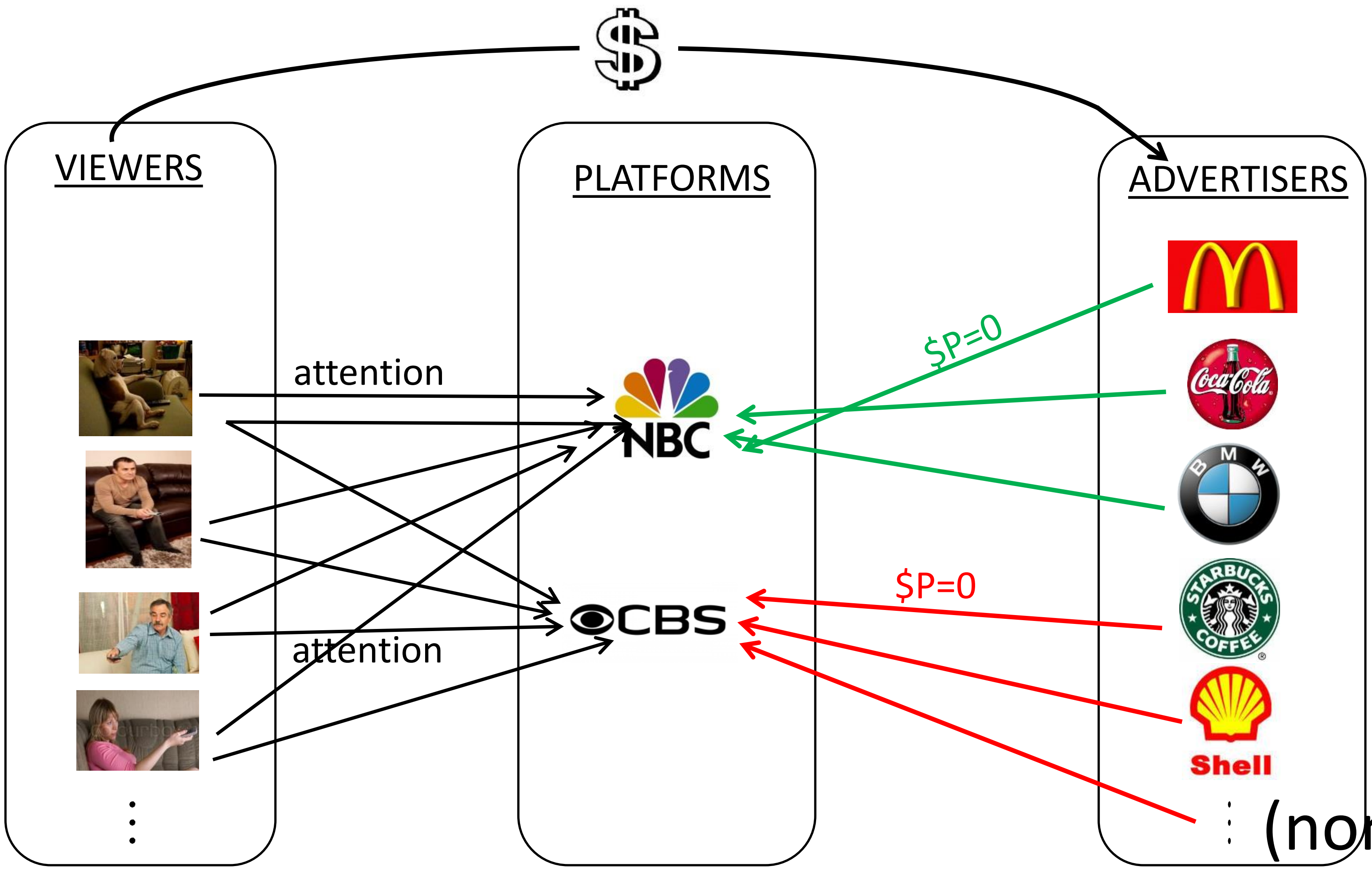
(half of viewers are on each channel and Price/viewer is ½)

Independent of ad nuisance, γ, because unobserved ad level (hold-up)

- Viewers anticipate ad levels and nuisance
- Condition for equilibrium is that middle viewer doesn't want to add another Channel: $t > t^{SHV} = 2(\psi - \kappa/2)$ with $\kappa = \gamma/\delta$

(t big enough, δ small enough)

Book-end FMHV (& SHA)



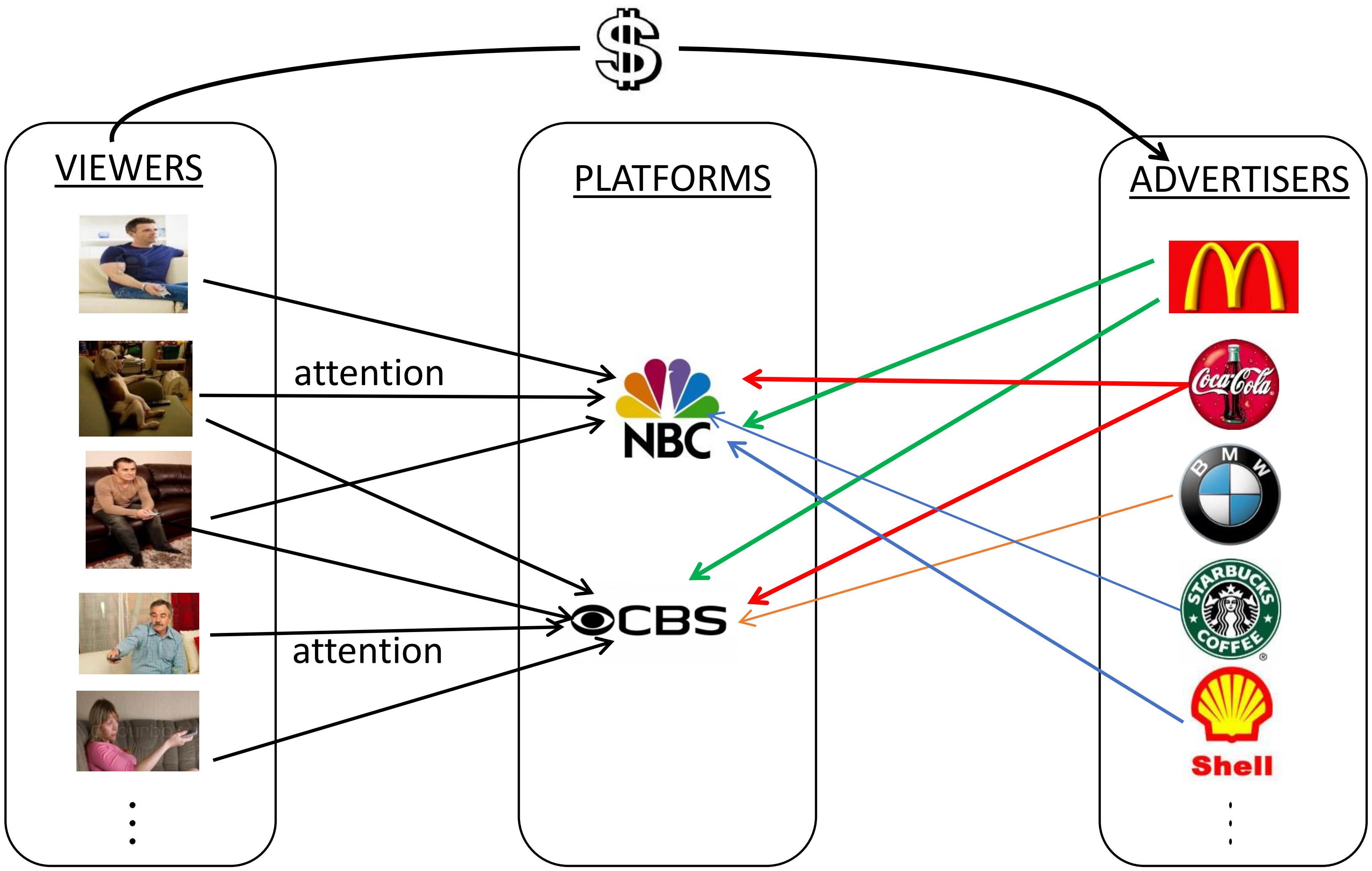
(non-overlapping)
a=1/2 on EACH

Book-end: Full Competition (FMHV)

- If all consumers/ viewers Multi-Home then they can be picked up on either channel
- So platforms have no Exclusives and no market power: P=0
- (if there were a benefit from second impression, P would be that)
- Viewers all multi-home so advertisers don't have to (so again a = ½ on each channel)
- Condition for equilibrium is that extreme viewer doesn't want to drop worse Channel: $t < t^{FMHV} = \psi - \kappa/2$ with $\kappa = \gamma/\delta$

(t small enough, δ big enough)

Asymmetric eq: PMHV & PMHA



More advertisers where fewer viewers: $r_2 > r_1$ $P_2 > P_1$ $a_2 < a_1$

Partial Multi-Homing Viewers (PMHV)

- We'll posit viewer allocations (expected fractions on 1,2,c)
- Then find platform prices *given* these
- Then find advertiser fractions on each channel
- Then determine viewer utilities and hence their allocations
- Thence find fixed point – equilibrium allocations

(if exists) consistent with regime

- Throughout, call 2 the platform with fewer ads / more viewers

$r_2 > r_1$ as $a_2 < a_1$

- Endogenous asymmetric net "qualities"

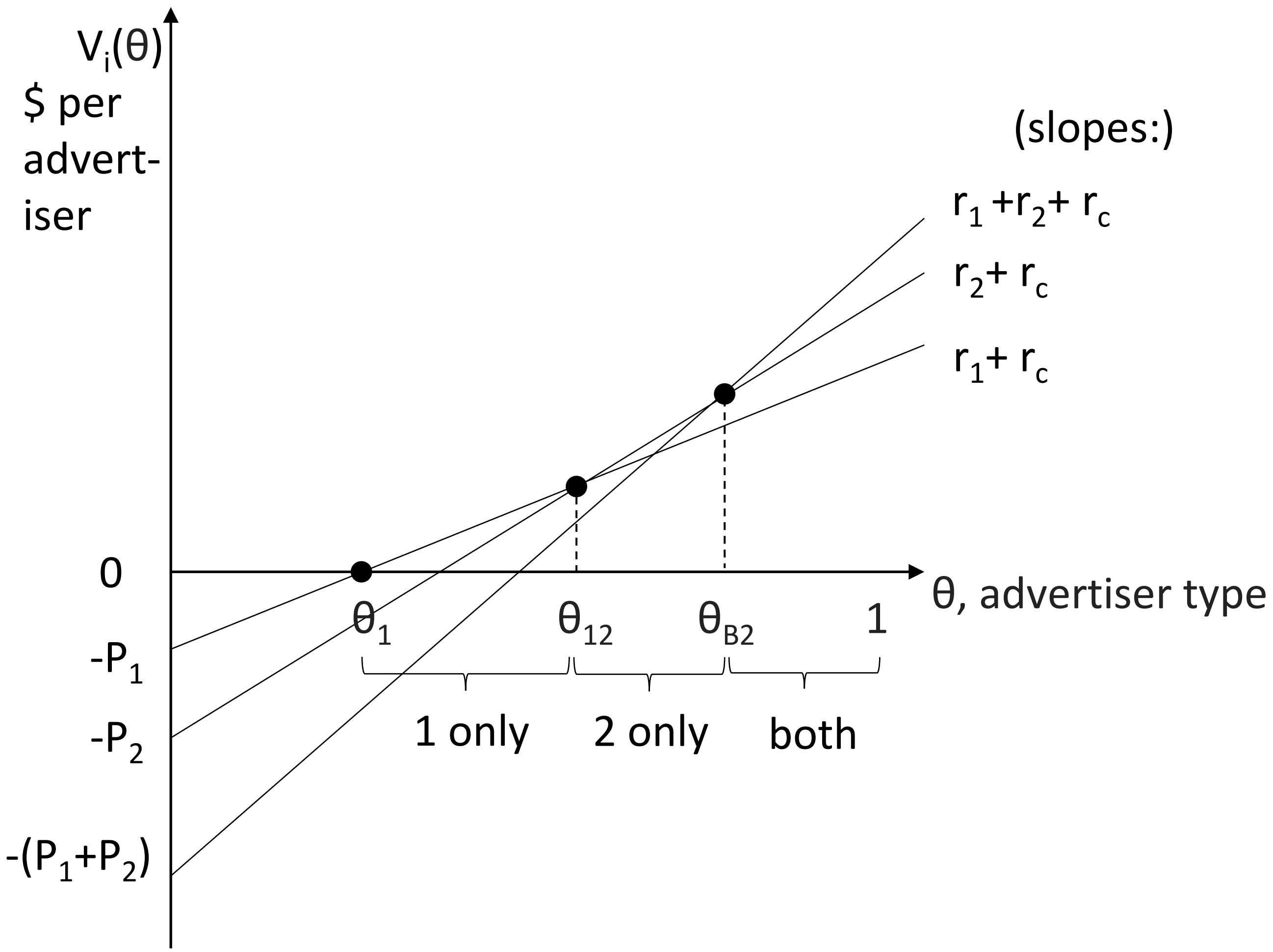
Both Sides Multi-Home Partially

- If consumers partially Multi-Home then advertisers **MUST** as well
  - No {B,0} since marginal advertiser θ_{0B} indifferent between advertising at Both and not at all gets no profit but would make positive profit on just one platform (not paying for wasted impressions)
  - No {B,i,0} since the optimal prices given ad demands imply equal ad levels (*a*=½) so advertisers would advertise on both and not just platform i
  - No {B,1,2,0} since lowest advertising type θ_{02} would Single-Home at 2. But then the platform with more consumers has a lower advertising price.

Implying only possible solution is {B,2,1,0} -> diagram!

Only asymmetric equilibrium type is {B,2,1,0}

Net utilities from ad choices;
Choice is upper envelope



{B,2,1,0} as a Candidate Equilbrium

- (1) find advertiser indifference points (next slide)
- (2) derive demand
- (3) find Price reaction functions from platform profit maximization
- (4) find restrictions on variables
- (4) verify 0 < $\theta_{01} < \theta_{12} < \theta_{2B} < 1$

Advertiser Side: Vertical Differentiation

- **Multi-Homing Advertisers: value**

$$V_i = \Theta(r_i + r_c) - P_i$$

$$V_B = \theta(r_1 + r_2 + r_c) - P_1 - P_2$$

Hence demands

$$a_1 = (1 - \theta_{2B}) + (\theta_{12} - \theta_{01})$$

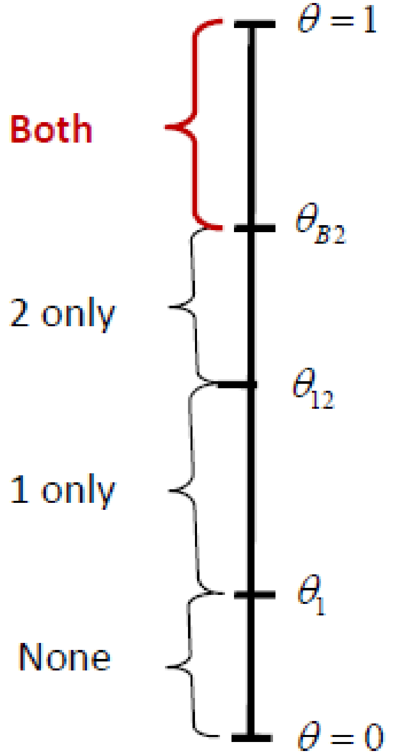
and

$$a_2 = 1 - \theta_{12}$$

$$\theta_{B2} = \frac{P_1}{r_1}$$

$$\theta_{12} = \frac{P_2 - P_1}{r_2 - r_1}$$

$$\theta_1 = \frac{P_1}{r_1 + r_c}$$



Now duopoly Price game: maximize profits and check consistency that $0 < \theta_{01} < \theta_{12} < \theta_{2B} < 1$

- Conditions:

$\theta_{12} < \theta_{2B}$ iff $r_c > r_1$ iff $t < t^H = \psi - k/2$

- $r_2 > r_1$ (as $a_2 < a_1$) iff $\psi < 2\kappa$
- $r_1 > 0$ if $t > t^L \approx 0.96\,\psi - 0.47\kappa$ and $\psi > ¾\kappa$

(recall $\kappa = \delta/\gamma$)

Upshot: Necessary and sufficient conditions for the existence of an asymmetric equilibrium are that t 2 (t^L,t^H) and ψ 2 (¾κ, 2κ). Some, but not all, of the agents on each side of the market multi-home in the asymmetric equilibrium (PMHV - PMHA).

[t^H is also the upper limit to the FMHV regime]

- Here's the pics:

Figure 1: *Symmetric and asymmetric equilibria* ($\Psi = 5.0,\ \kappa = 2.5$)

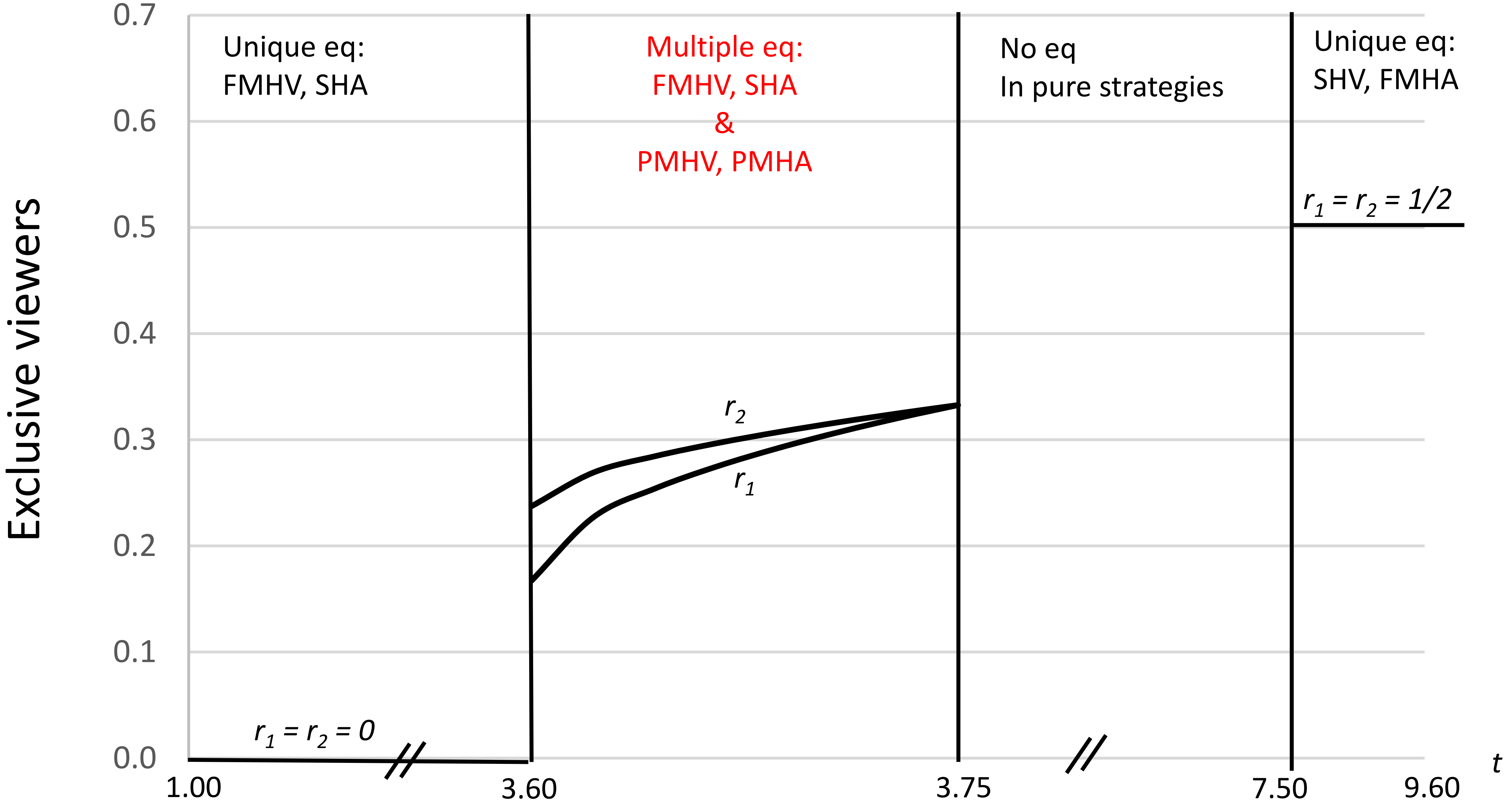
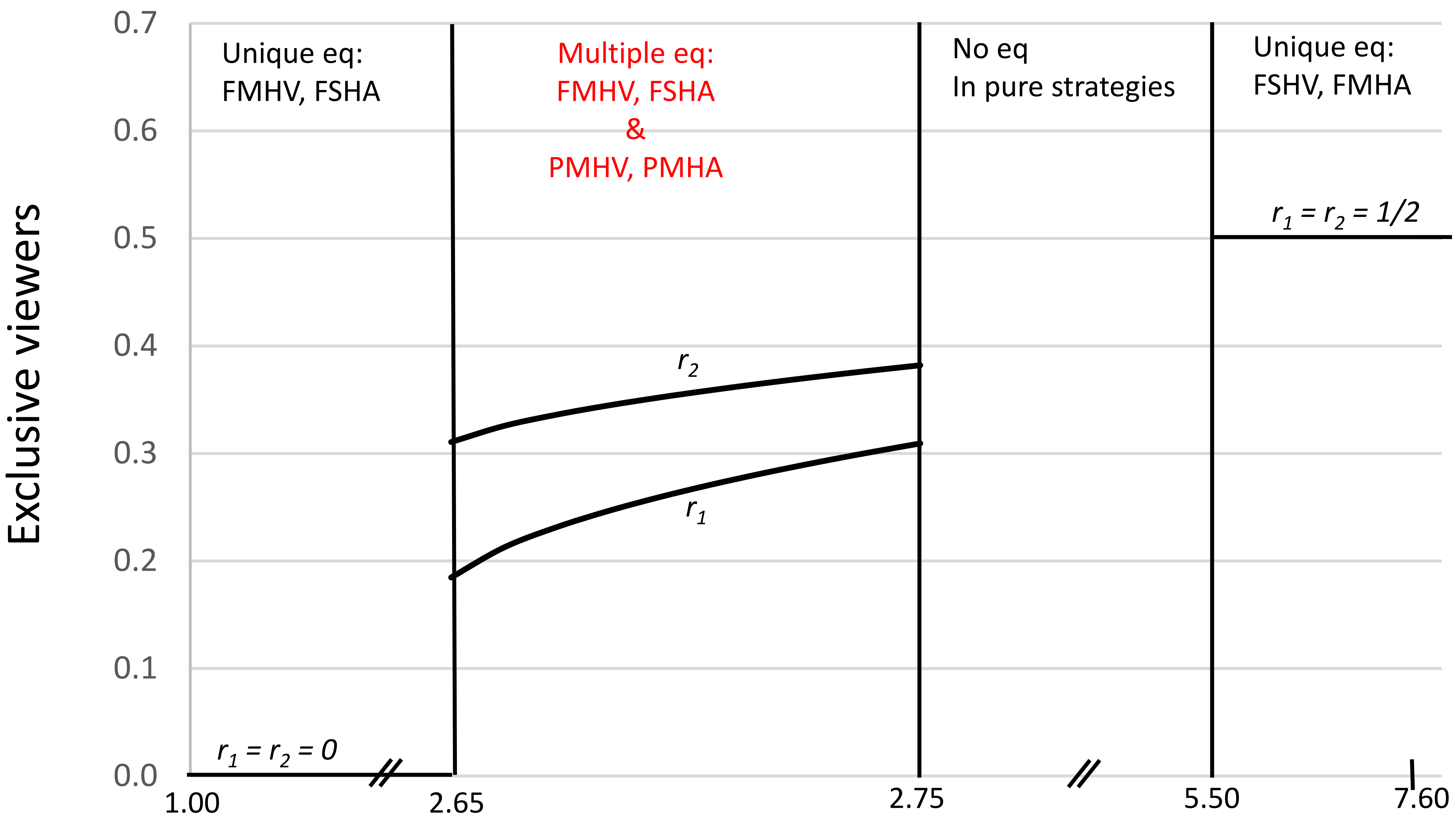


Figure 2: *Symmetric and asymmetric equilibria* $(\Psi = 4.0,\ \kappa = 2.5)$



Endogenous partial multi-homing regime

- We have endogenous asymmetry despite symmetric starting point
- All driven by a single choice variable, Price per Ad
- Somewhat recalls Gabs-Thisse & Shaked-Sutton Vertical differentiation, but that was a 2-stage (quality-then-price) game

- We have platform with more viewers has *fewer* ads
- This contrasts with standard (bottleneck) model (and observed ad levels as strategic variable) –

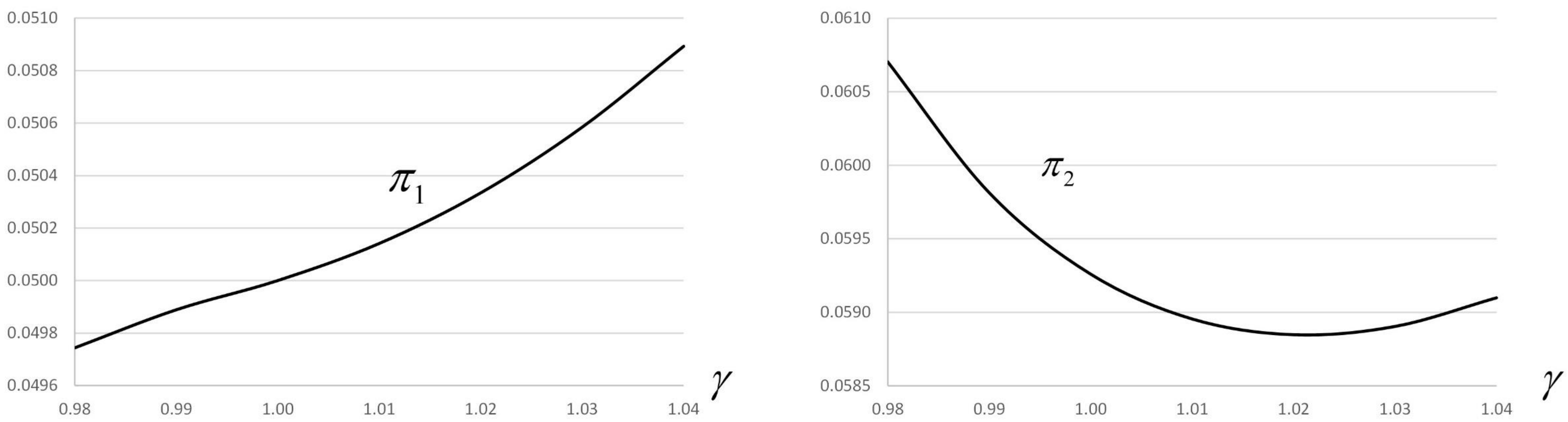
Anderson-Peitz (JET20) show exogenous qualities positively correlate with HIGHER ad levels (leverage advantage to air more ads)

- However, AP (AEJ-Micro) have a similar result but with ad congestion (also with exogenous differential qualities and obsd ads as strategic variables) – larger players have more at stake in the common property of viewer attention

- Some evidence this can happen – Norway's premier private channel doesn't want to relax its ad cap

- What happens to profits in the asymmetric equilibrium as ad nuisance goes up?:

Figure 3: *Partial multihoming. Profit as a function of disutility of ads.*



$\Psi = 4$ and $\delta = 0.4$.

Profit and ad nuisance

- Higher nuisance can improve profit!
- Echoes of Grossman-Shapiro RES84 (higher informative ad costs reduce overlapping competitive footprint and relax competition)

- higher γ has 2 effects:

Direct hurts platform

Indirect is that reduced overlap means less Multi-Homing Viewers means less competition for advertisers

- Merger implication: incentive to merge is less with higher nuisance cost because then less overlap before merging ?

conclusions

we combine 2 canonical preference heterogeneity models,
extended to allow for multi-homing,
along with ad-price competition and rationally-anticipated ads
to deliver a regime of endogenous multi-homing
on both viewer and advertiser sides
and endogenous platform asymmetry
where higher ad nuisance costs can raise profits

Further directions

- Alternative timing and strategic variable
- Prices per ad vs. ad levels as strategic variable
- (non-)observable ads
- Need to compare all 4 alternatives

- Add time-use
- Add subscription prices -- Print media
- Add ad targeting – Web-sites
- Add temporal consumption – TV / radio

Compare with ad prices OBSERVED & ad levels set by platforms

- How to do it?
- Use earlier eqs for θ's and r's to write P's as functions of a_1 and a_2
- These (after simplifying) are ad-market-clearing prices
- then duopoly game with a's as choice variables

- Gives "2-sided market balance" eqs with ad levels internalizing (unilateral) effects on ad Prices and Viewers
- (Unilateral) incentive to keep ad levels high to induce SHV and avoid MHV insofar as MHV toughens competition
- Suggests free ride on other's ad effort – too many ads from platforms' perspective

What changes or similar?

- No longer “passive” market
- Two sided market balance returns when coordinated

- Still regimes: SHV and PMHV/PMHA for same reasons!
- (but FMHV will go – platforms avoid it!)
- SHV will be classic AC: no full monopoly hold-up – but “worse” because ad levels BELOW monopoly levels!
- In that regime, ad nuisance hurts profits and reduces ad levels further

THANKS

Results Preview

- Single-Homing Viewers & Multi-Homing Advertisers
  - Platforms sell monopoly access to viewers
  - Monopoly Ad level
- Full Multi-Homing Viewers & Single-Homing Advertisers
  - Bertrand competition yields zero ad price
- Partially Multi-Homing Advertisers & Partially Multi-Homing Viewers
  - Positive ad price based on the level of *exclusive* viewers
  - Endogenous platform asymmetry
  - Higher ad nuisance costs can raise profits

No other Regime type can exist

30’ version? OF

- You better than me here, I guess. Just some suggestions
- Slide2: I like that you start out making us relevant wrt the empirical findings of Gentzkow et al and policy discussion of Athey and Scott M. But do you need to emphasize that our paper is an old-age one?
- Slide 4 may be done as voice over voice over slide 3 (the fig)? (we don’t discuss the puzzles on entry, mergers and public broadcasters in the current paper, so a detour?)
- Slide 5 (*literature*) may just be moved to a final slide, if slides are shared. You probably *don’t have time to discuss* this?
- I like slide 6 (building blocks). However, the last bullet give the impression that the model is more stylized than it is (?) “No benefit for a second impression per viewer”. The important feature is that second impression worth less than first impression [stet: would we have 2 impressions on same channel then?]
- May merge slide 7 ad 8? yes
- The figs on slide 10 (viewers) and 12 (ad side) explain the key mechanism, may take slide 9 as voice over here? OK!
- Why have both 10 and 11? flash
- I like your story from slide 13 to 19 to show the {B,2,1,0} as a Candidate Equilbrium. But may skip some of them OK

sketch

- brief o-view of 2SM ad-fin version
- Then res q’s (answered at end summary perhaps)
- Diagram of sides; of HD, VD; regimes pic (to do);
- Eqm regime as fn of gamma
- Gamma nuisance
- summary

2SM back-drop: ad-financed media mkts

- A canonical 2SM setting
- Participation benefits depend on other side presence
- Viewers dislike ads; advertisers want viewers (consumers)
- Mediated via platforms choosing ad levels (SINGLE instrument)
- Different from canonical “night-club” models (symmetric U’s) with 2 prices and Credit cards
- Different from buyer-seller (eg Amazon)

Ad level determines “price” on BOTH sides! (hence see-saw effects)

- Draw pic p/ad/viewer vs ad level (=price to vwrs)

- Platform profit pi = $P(a)N(a) = ap(a)N(a) = R(a)N(a)$

(want $R(a)$ on last slide)

- Hence "two-sided market balance" eq: $R'/R = N'/N$
- (oligopoly too)
- Ad levels BELOW "monopoly" level $R'=0$!

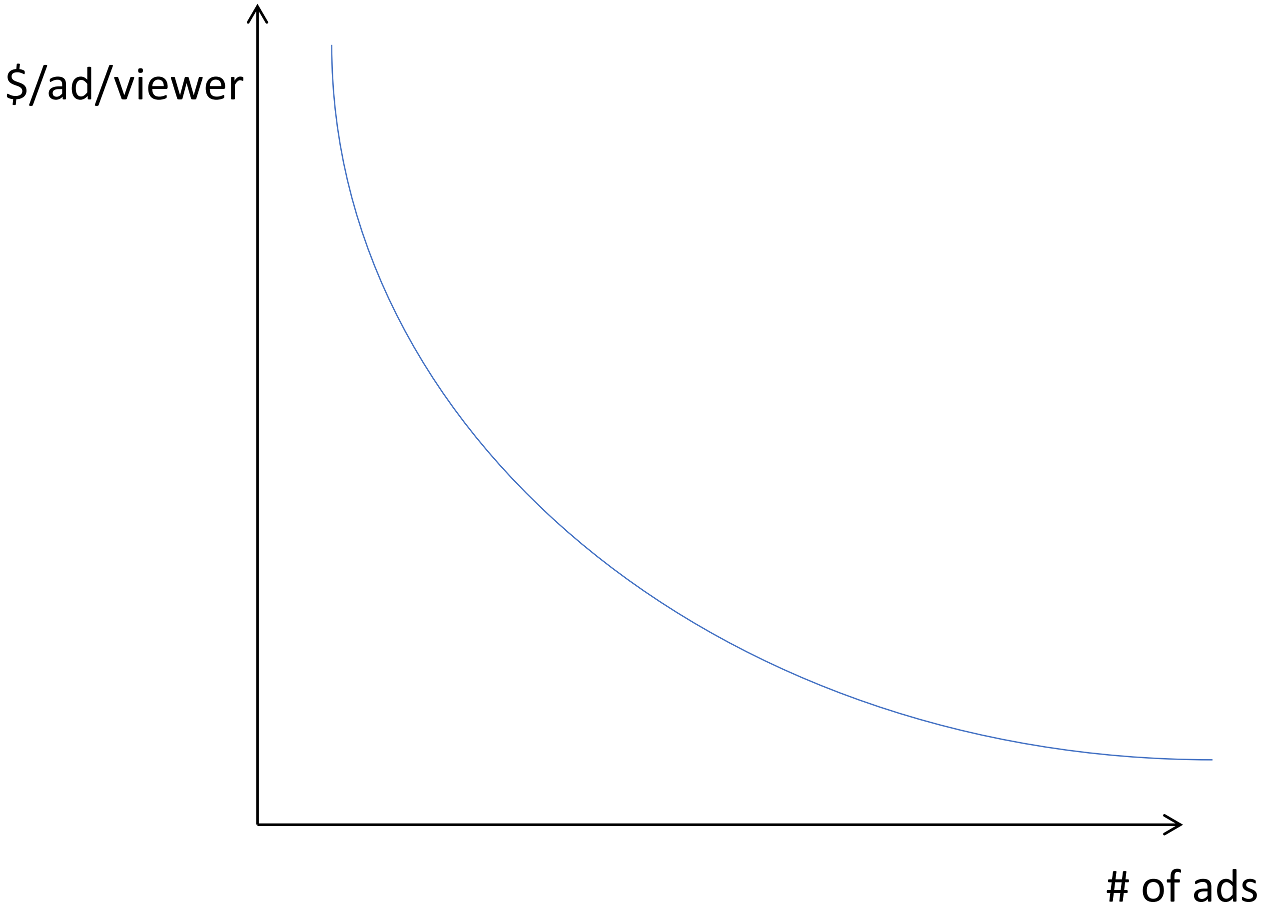
Ad-level determines ‘price’ on both sides!

- If change (entry, merger) causes
- Price to viewers ⬇
- then price to advertisers ⬆

(but number of viewers ⬆

so $P/ad is ambiguous)

Hence “see-saw” effects



Why Multi-Homing (MH) Matters? [drop?]

- No ‘competitive’ (monopoly) bottleneck
- Results in direct competition for advertisers

- Previous Work (EJ17 paper w/FK; also IJIO14 w/FKP)

Single-Homing Consumers/Viewers implies

  - Entry raises per viewer ad prices
  - Mergers decease ad prices
  - Private broadcasters welcome public broadcaster carrying ads

- Results can reverse with Multi-Homing Viewers

Also Anderson-Peitz23 Information Congestion approach

What difference does x make; x=

- Downslope dd
- Unobserved ads

Actually raise eqm ads! And decrease their price / viewer
Because underads (rel to monopo) before

- Does MH destroy profits
- How strategize to get SH if so? (free-ride)
- How square importance of MH with empirics?
- Firms can’t avoid MH?

Research questions (answers on end slide!)

- What difference does downslope ad demand make
- Nice sorting properties, best get matched to most

- Price PER ad, not per csr

- (when) do we get SH & what mean to pcg & on what side? Resp MH

SA

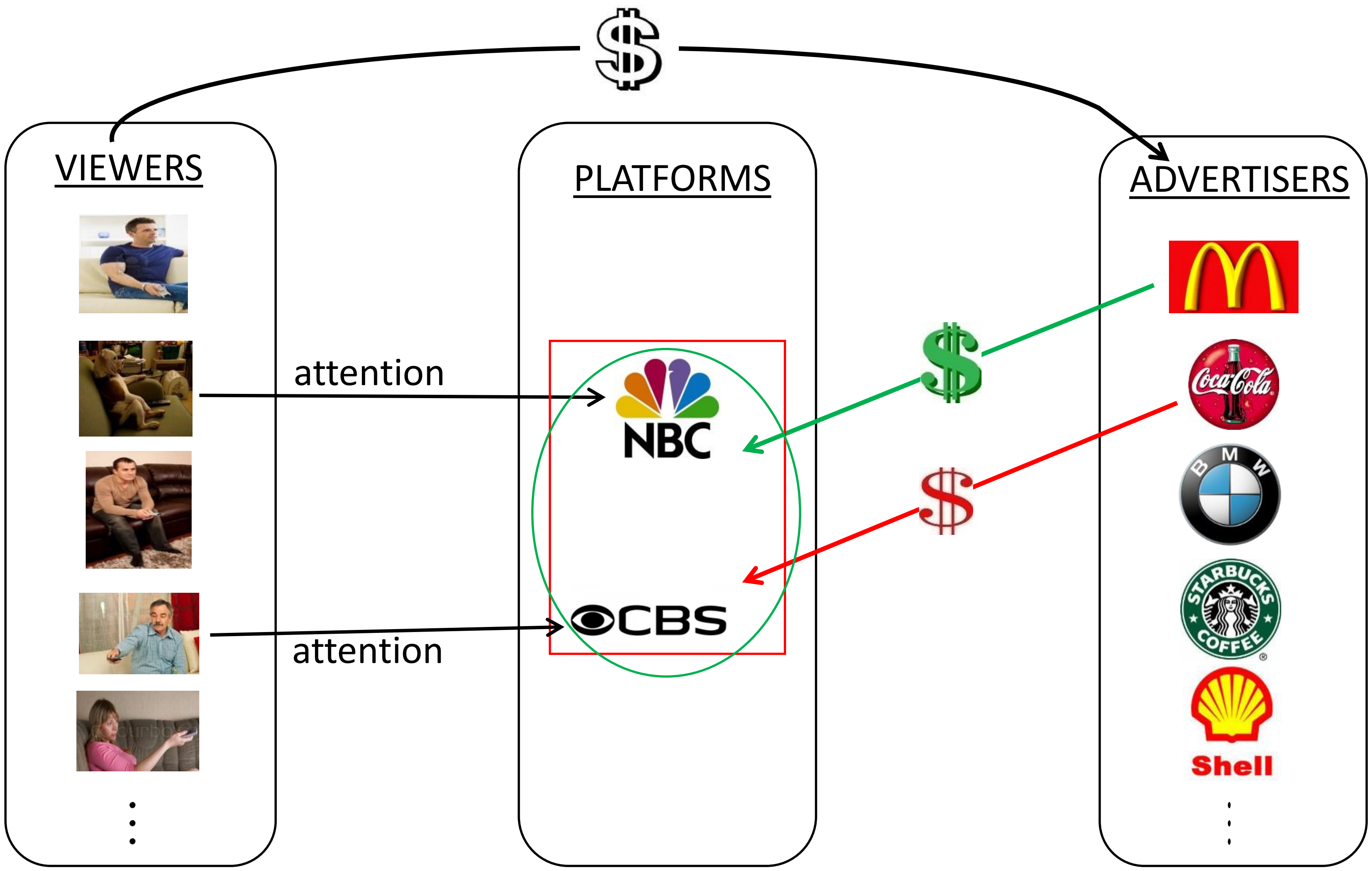
- Write model: csrs and advrs OK, say there's duopoly & give game timing
- Sharpen later – drop repeats of method
- Exist MSE ? Idk
- Take aways: asym outcome; gamma
- Import? (policy; insights)

SA (4MP?)

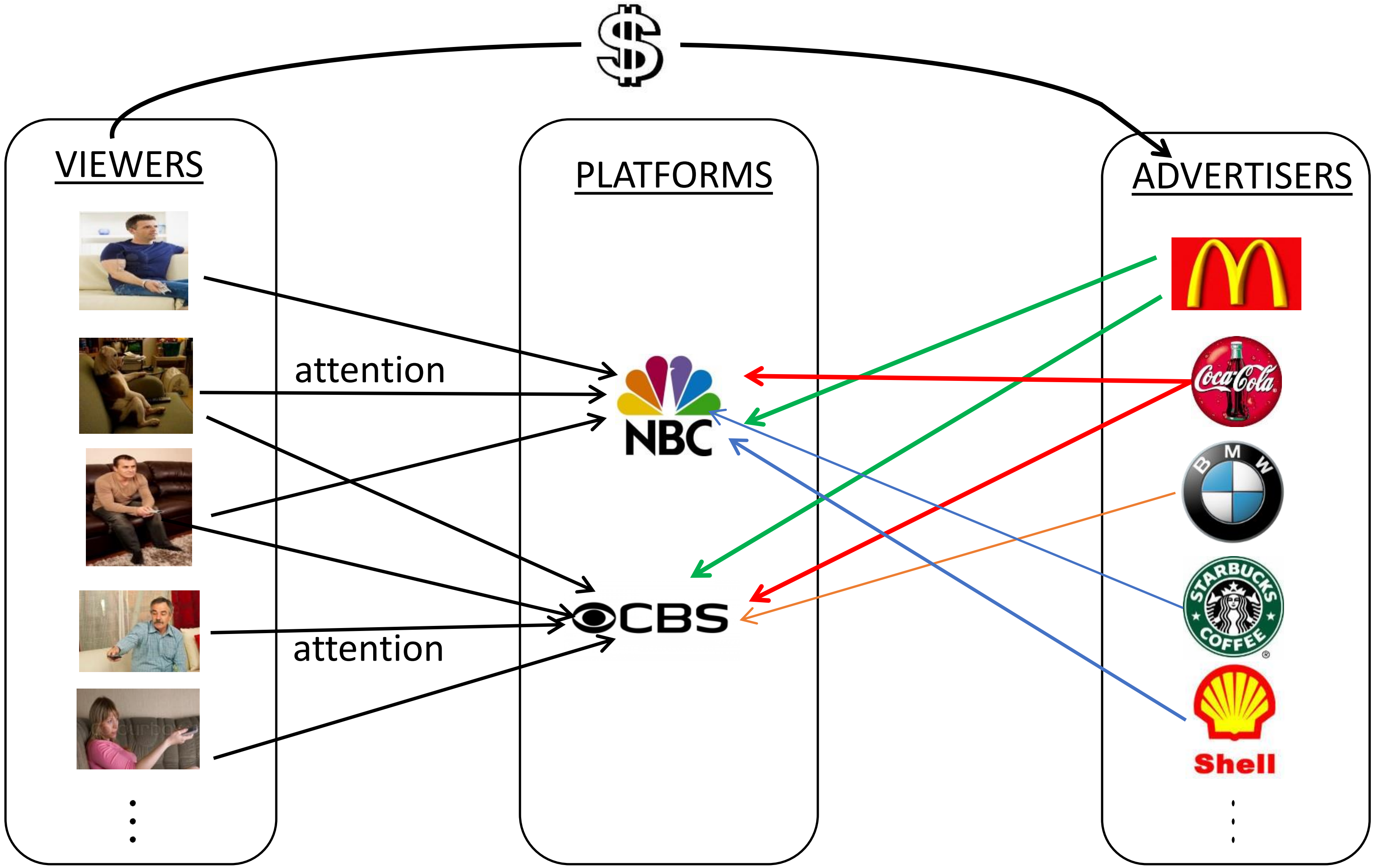
EC: point / obj?

- SM: Sarit: Hanna & Bakos have cross-side subs result disappears w/ MH! She thought the Price discrim one might too, Alex de C paper
- Write out all key properties of 2SM/platforms. Which assume SH on one side?
- Our insights: intro comp in the other mkt kills the 2SM result!
- How far does this extend. Depend on structure of MH? Ours is MHA/SHV

2-sided business model

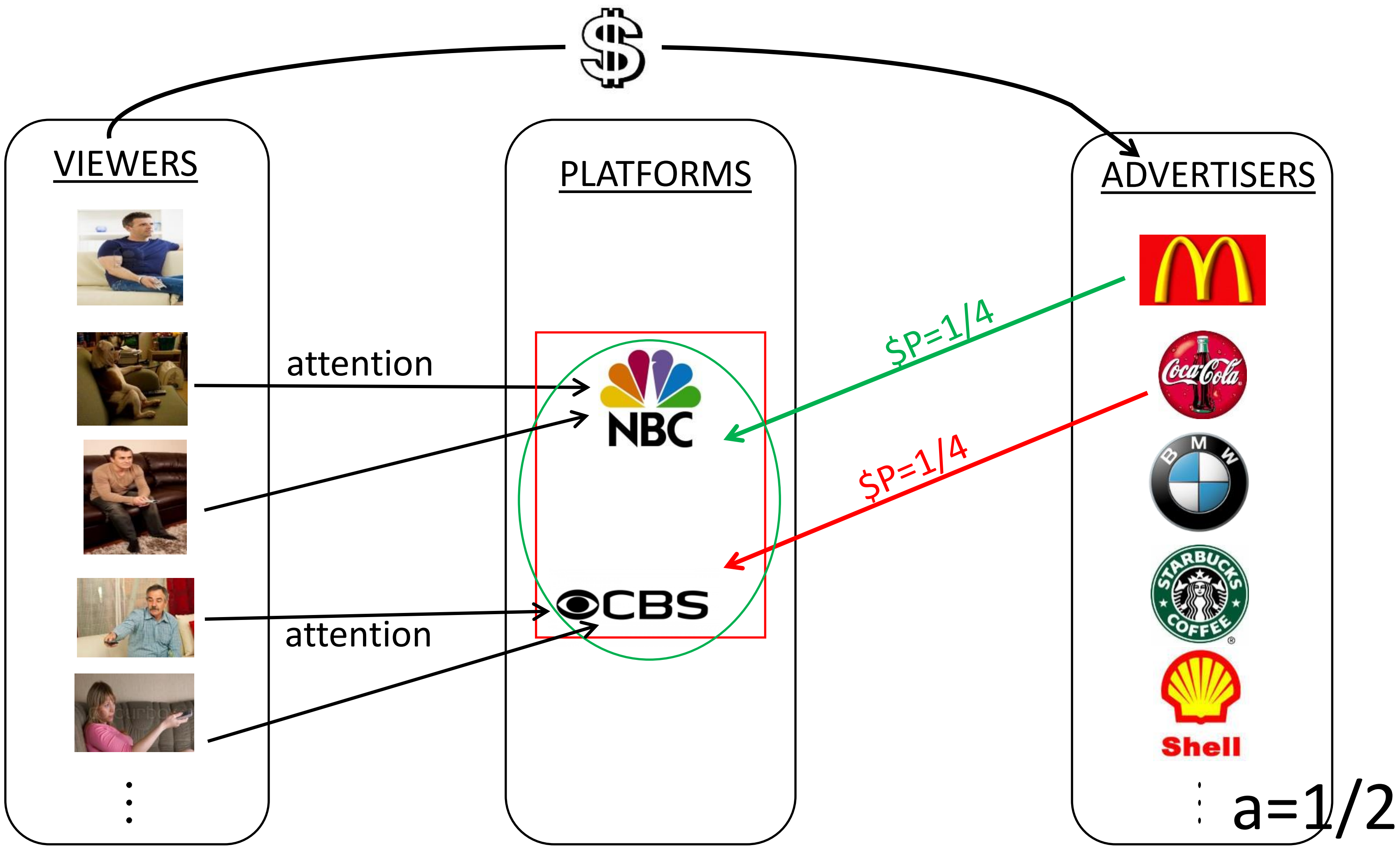


Asymmetric eq: PMHV & PMHA

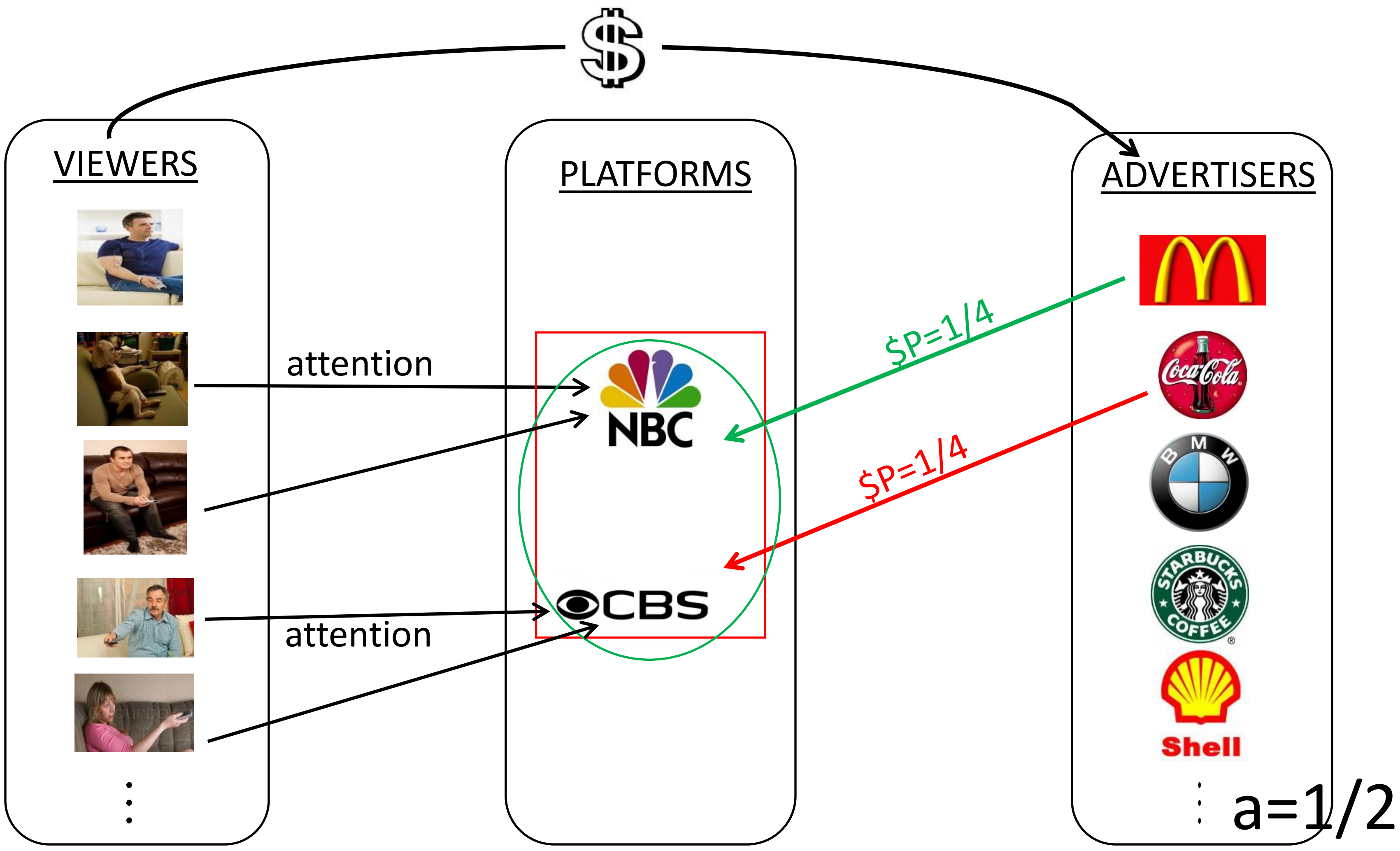


More advertisers where fewer viewers: $r_2>r_1$ $P_2>P_1$ $a_2<a_1$

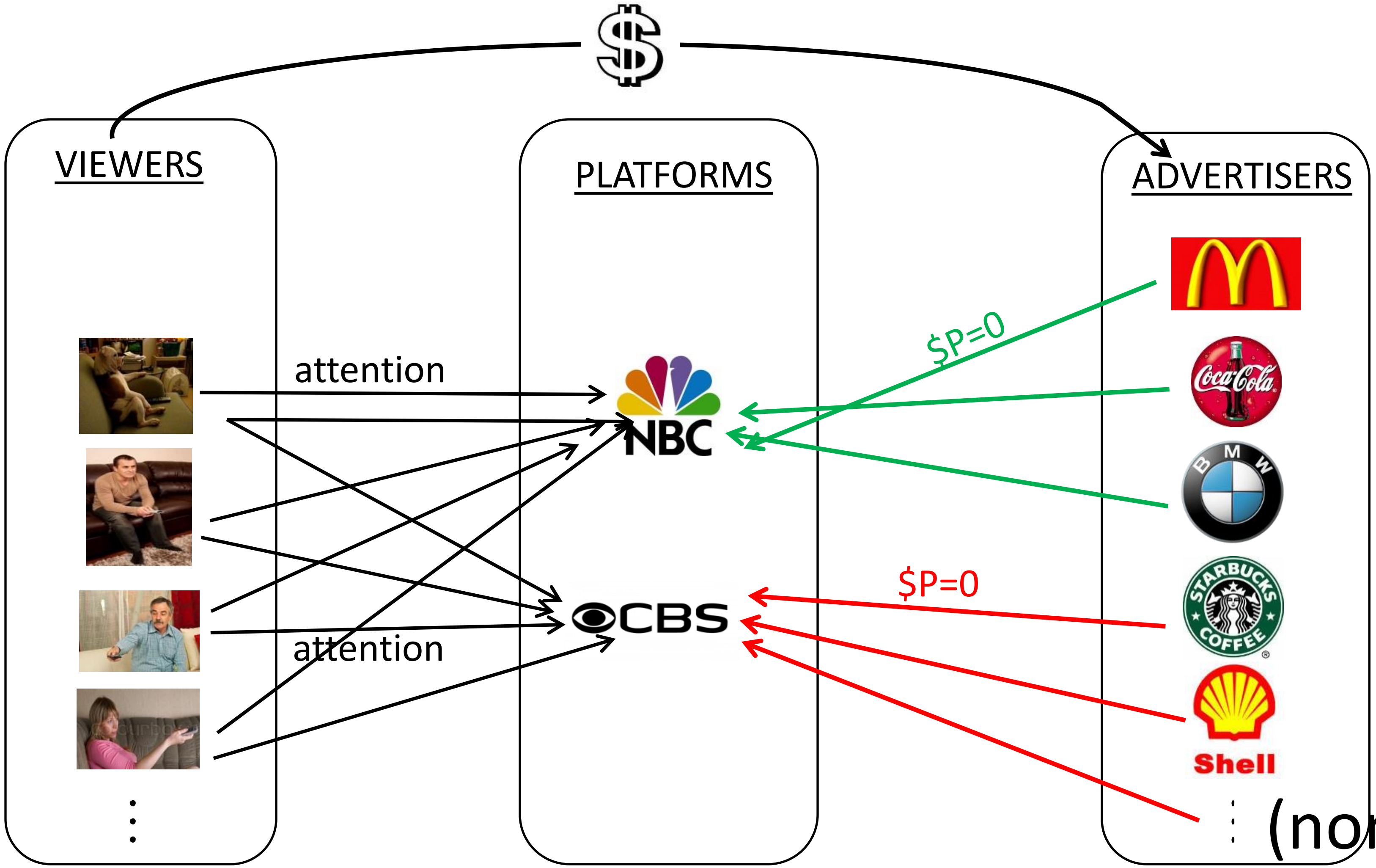
2-sided business model SHV & MHA



2-sided business model SHV & MHA

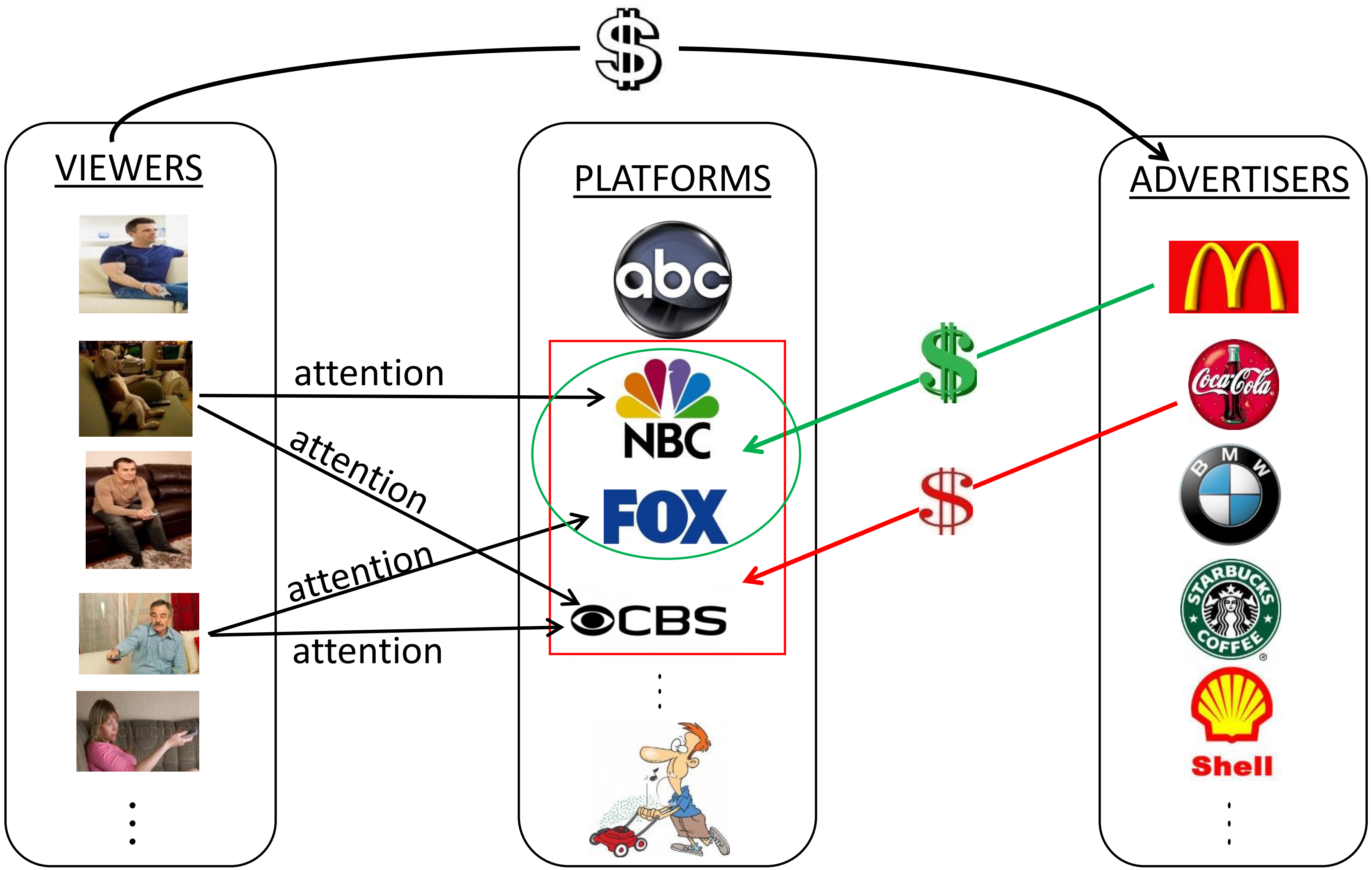


2-sided business model FMHV (& SHA)



(non-overlapping)
a=1/2 on EACH

2-sided business model



2-sided business model