# Set-Valued Channel Demand in Unbundling Counterfactuals: A Comment on Crawford and Yurukoglu (2012)

Chae-Yeon Xon
Yonsei University

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**Abstract**

Crawford and Yurukoglu (2012) value a channel set by optimizing viewing time. Their programs use proportional viewing and sum channel increments evaluated at one reference bundle. The printed Kuhn–Tucker allocation has corners, and the reference formula represents every selected set exactly under modularity. A two-channel economy changes purchases and surplus. The full à la carte programs also vary the household choice kernel across bargains and use different smoothing scales for demand and welfare. A replacement uses one set-value and one shock law throughout bargaining, demand, and welfare. The released tables reproduce the channel count; computing national welfare requires the fitted household and equilibrium state.

*JEL Codes:* D12, L13, L82
*Keywords:* bundling, viewing time, set utility, counterfactuals, bargaining, consumer surplus

Yonsei University. eunixon@yonsei.ac.kr. Early stage draft; please do not cite or circulate without author's written permission. All errors are my own.

## 1. Introduction

Crawford and Yurukoglu (2012) estimate household preferences for multichannel television and use the estimates to study unbundled channel sales. A household first chooses a distributor and package, then allocates a time endowment across the available channels and an outside activity. Equations (1)–(3) define the value of every available set through this allocation problem. The full à la carte experiment expands the household's feasible channel sets and renegotiates affiliate fees through a bargaining model.

The distributed source evaluates three different household operators along this calculation. The demand estimator assigns viewing time in proportion to channel tastes. The à la carte branch computes each channel's utility increment at a fixed 24-channel bundle and sums those increments over the selected set. Bilateral disagreement profits use a choice kernel indexed by the channel under negotiation, while the welfare routine uses another within-provider scale. These operations select viewing, purchases, bargaining payoffs, and surplus.

This Comment aligns the program operators with the preference model. Solving the printed time-allocation problem first makes its difference from the proportional rule visible. The fixed-reference projection then yields a two-channel purchase reversal, while the bargaining and welfare calculations point to a common household choice law. The public tables and released inputs support these operator comparisons and the finite counterfactuals. A replacement algorithm gathers them into one calculation. Revising Tables 8–10 requires the fitted household array, provider constants, input-cost state, and saved bargaining equilibria used in the published run.

## 2. The viewing-time operator

For household $i$ and an available activity set $A$, including the outside activity, the article defines

$$v_i^*(A) = \max_{t_c \geq 0} \left\{ \sum_{c \in A} \gamma_{ic} \log(1 + t_c) : \sum_{c \in A} t_c \leq T \right\}. \tag{1}$$

Let $A_i^+$ denote the active set. The Kuhn–Tucker multiplier and allocation are

$$\lambda_i(A) = \frac{\sum_{c \in A_i^+} \gamma_{ic}}{T + |A_i^+|}, \qquad t_{ic}^*(A) = \frac{\gamma_{ic}}{\lambda_i(A)} - 1 \quad (c \in A_i^+), \tag{2}$$

where $A_i^+ = \{c \in A : \gamma_{ic} > \lambda_i(A)\}$ and the remaining times are zero. Sorting the coefficients and checking this inequality determines the active set.

The demand assembler in the distributed program uses

$$\widetilde{t}_{ic}(A) = T\frac{\gamma_{ic}}{\sum_{a\in A}\gamma_{ia}} \tag{3}$$

for every positive coefficient. Under an interior printed solution, the time share satisfies

$$\frac{t^*_{ic}(A)}{T} = \frac{\gamma_{ic}}{\sum_{a\in A}\gamma_{ia}}\left(1+\frac{|A|}{T}\right) - \frac{1}{T}. \tag{4}$$

Equations (2) and (3) coincide when the active coefficients are equal. More generally, the proportional rule solves the allocation with $\log t_c$ in place of $\log(1+t_c)$ and assigns positive time to every positive coefficient.

The difference reaches the estimation moments. The distributed Fortran assembler constructs (3), its analytic Jacobian differentiates that rule, and the main objective sends the resulting time levels and positive-viewing indicators into ratings, covariance, and cume moments. Under (2), a channel with $\gamma_{ic} > 0$ can receive zero viewing time.

For example, take $T = 10080$ and $\gamma = (1, 1, 0.00015)$. The two allocations are

$$t^* = (5040, 5040, 0), \qquad \widetilde{t} = (5039.6220, 5039.6220, 0.7559). \tag{5}$$

If the third coefficient is replaced by zero, the printed full-set allocation and value remain unchanged. With only activities one and three available, the positive third coefficient becomes active because $0.00015 > 1/(T+1)$, and the two economies have different set values. Thus an observed allocation on one bundle does not determine the set values used in the à la carte experiment.

## 3. Fixed-reference channel values

Normalize the value of a channel set $S$ relative to the outside activity as

$$W_i(S) = v^*_i(S \cup \{0\}) - v^*_i(\{0\}). \tag{6}$$

Fix a reference channel set $B$. The distributed source computes the channel increments

$$m^B_{ic} = \begin{cases} v^*_i(B\cup\{0\}) - v^*_i((B\setminus\{c\})\cup\{0\}), & c \in B, \\ v^*_i((B\cup\{c\})\cup\{0\}) - v^*_i(B\cup\{0\}), & c \notin B, \end{cases} \tag{7}$$

and assigns the selected set the additive value $\widetilde{W}^B_i(S) = \sum_{c\in S} m^B_{ic}$.

PROPOSITION 1 (Fixed-reference equivalence). *For a fixed reference $B$, $W_i(S) = \widetilde{W}^B_i(S)$ for every selected set $S$ exactly when $W_i$ is modular with singleton coefficients $m^B_{ic}$.*

PROOF. If $W_i$ is modular with those coefficients, substitution gives the equality. Conversely, equality for every $S$ is itself an additive representation of $W_i$ with coefficients $m_{ic}^B$. □

The common time constraint in (1) creates set-dependent marginal values. The following economy makes the consequence explicit. Set $T = 1$ and give the outside activity and two channels coefficient one. Then

$$(8) \qquad v^*(\varnothing) = \log 2, \qquad v^*(\{1\}) = v^*(\{2\}) = 2\log(3/2), \qquad v^*(\{1,2\}) = 3\log(4/3).$$

Using $B = \{1, 2\}$, each reference increment is

$$(9) \qquad m = \log(256/243) = 0.0521160011.$$

Charge each channel $p = 1/18$. The fixed-reference rule buys zero channels because $m < p$. Under the printed set values, the net gains from one and two channels are

$$(10) \qquad \log(9/8) - \frac{1}{18} = 0.0622274801, \qquad \log(32/27) - \frac{1}{9} = 0.0587879257.$$

The household buys one channel and obtains the first gain. With independent unit-scale extreme-value shocks over the four sets, expected purchases are 1.0144547368 under the printed set values and 0.9982802245 under the projection; the inclusive-value difference is 0.0495945155.

## 4. One household choice law

A bargaining counterfactual evaluates agreement and disagreement profits for many bilateral negotiations. For fixed household primitives, channel prices, and availability, one demand system assigns one probability to each feasible set. The distributed à la carte evaluator instead smooths the channel currently under negotiation and thresholds the remaining channels. Changing the focal bargain therefore changes the household choice kernel at the same economic state.

Take generalized utilities $(x_1, x_2) = (0.2, -0.2)$ and the source scale 0.3. When channel one is focal, its purchase probability is 0.6607563688 and channel two has probability zero. When channel two is focal, channel one has probability one and channel two has probability 0.3392436312. The two arrays index the same household and prices by different bargaining labels.

The welfare routine uses within-provider scale 0.2, while the equilibrium demand routine uses 0.3. At generalized channel utility 0.2, with an outside option and the released outer nest, equilibrium channel demand is 0.3834861613. The negative price derivative of the welfare formula is 0.3923854458, leaving envelope residual

$$-\frac{\partial CS}{\partial p} - D(p) = 0.0088992845. \tag{11}$$

The sign convention in (11) reports the magnitude; direct subtraction $D + \partial CS/\partial p$ equals $-0.0088992845$. Under one random-utility law, the expected-surplus envelope equals the associated demand at smooth price points. A common scale and common shock vector across bargains restore this identity.

## 5. What the public tables identify

Tables 8 and 9 permit a unit reconstruction of channel purchases generated by the released à la carte calculation. Let $b_c$ be the bundling input cost, $p_c$ the à la carte input cost, $g_c$ the reported percentage change in license revenue, and $P_B = 0.880$ the bundling penetration rate. Since every bundling subscriber receives every listed channel, the à la carte purchase rate per U.S. television household is

$$q_c = P_B b_c \frac{1 + g_c/100}{p_c}. \tag{12}$$

Across 49 rows, $\sum_c q_c = 18.9483584585$. Dividing by the reported à la carte penetration rate 0.993 gives 19.0819319824 channels per subscriber. Independent intervals based on the displayed rounding give [18.5452, 19.6347] after conditioning, which contains Table 8's reported 19.3.

The 24 channels in the code's reference bundle account for 11.0038608310 purchases per television household. The other 25 channels account for 7.9444976275, or 41.927 percent of the reconstructed incidence. Mixed selected sets therefore cross the reference boundary frequently in the released calculation. Their exact set-value correction depends on each household's joint channel tastes and selected set, which the table marginals do not recover.

The archive labels its replacement household inputs as artificial data that preserve program structure. A calculation using the distributed parameter shell, 1,500 households, mean released demographics, independent Latin-hypercube draws, and an identity copula gives mean normalized reference-set value 4.9264781817 and mean additive reference projection 4.8043917950. Their gap is 0.1220863867 utility units, or 0.3722626062 per month under the price coefficient used by the source. Under the same inputs, the mean value gap between (2) and (3) is 0.0000948325 utility units, or 0.0002995675 per month. These figures compare the two source operators within the released inputs. They are separate from the fitted household population and provide no revised national welfare estimate.

The missing sufficient state consists of the fitted weighted household array, joint taste and zero-mass draws, price coefficients, provider constants and outer scale, channel avail-

TABLE 1. Calculations supported by the published tables and released inputs

| Object | Evidence | Result |
|---|---|---|
| Released channel purchases | Published Tables 8–9 | 19.0819 channels per à la carte subscriber |
| Reference-set projection | Released artificial inputs | 0.3723 dollars per month in the comparison sample |
| Viewing allocation rule | Released artificial inputs | 0.0003 dollars per month in the comparison sample |
| National welfare in Tables 8–10 | Fitted joint state unavailable | Requires household-level tastes, provider states, costs, and saved bargaining equilibria |

ability and ownership, advertising revenue, distributor-specific input costs, bargaining parameters, and the saved agreement and disagreement equilibria. Public marginal tables admit many joint household arrays with different set-specific corrections and switching masses. Substitute microdata can therefore reproduce source mechanics and finite examples; it cannot select the national values associated with the original fitted state.

## 6. Replacement counterfactual

For household $i$, provider $f$, channel availability $a_f$, access fee $A_f$, and channel prices $p_{fc}$, define the within-provider problem

$$\max_{x_c \in \{0,1\},\, t_c \geq 0} \left\{ \sum_c \gamma_{ic} \log(1+t_c) + \alpha_i \left( A_f + \sum_c p_{fc} x_c \right) : \sum_c t_c \leq T,\ t_c \leq T x_c,\ x_c \leq a_{fc} \right\}. \tag{13}$$

For a finite channel list, enumeration over selected sets followed by (2) solves (13). Its optimized value enters the provider-choice equation. One joint draw of provider and channel shocks is retained across every agreement and disagreement calculation. Every Nash product then calls the same operator at its relevant availability and input-cost state, and consumer surplus is the expected maximum under those draws.

The construction has three testable implications. First, the viewing allocation satisfies the Kuhn–Tucker conditions in (2). Second, each set value agrees with a fresh solution of (1). Third, at smooth prices,

$$-\frac{\partial CS}{\partial p_{fc}} = \Pr\{\text{provider } f \text{ and channel } c \text{ are purchased}\}. \tag{14}$$

With deterministic channel selection, the last equality is read as the applicable directional derivative away from ties. With smoothing, one common scale and shock distribution enter all demand, bargaining, and welfare evaluations.

## 7. Scope

The correction applies directly to the mapping from equations (1)–(5) of Crawford and Yurukoglu (2012) into estimation and full à la carte computation. Parameters estimated through (3) describe that allocation rule; interpreting them as parameters of (1) requires re-estimation. Fixed-reference margins represent all selected-set utilities under the modularity condition in Proposition 1. Bargain-indexed kernels and distinct surplus scales require replacement by one household law before counterfactual profits and welfare share a common economic state.

The time-allocation preference, distributor bundle choice, moment inequalities for affiliate costs, and Nash bargaining architecture continue to apply. The exact two-channel economy establishes that the operator choice can change purchases and welfare. Computing the national magnitude for the published calibration requires the fitted household and bargaining states. The public tables and released inputs determine the operator comparisons reported here; the national tables require the original fitted states.

## 8. Conclusion

The printed model assigns every channel set the optimized value from a common time endowment. The distributed calculation uses proportional viewing time, fixed-reference additive channel margins, and bargain-dependent smoothing. Their equivalence requires conditions that the time-allocation model generally lacks. Solving the printed household problem at every selected set and carrying one choice law through bargaining and welfare aligns the counterfactual. Public outputs reproduce the released channel count and measure the two operator gaps in an artificial-data shell; the fitted joint state is the remaining input for revised national tables.

## References


Crawford, Gregory S. and Ali Yurukoglu. 2012. "The Welfare Effects of Bundling in Multichannel Television Markets." *American Economic Review* 102 (2): 643–685. `10.1257/aer.102.2.643`.


## Appendix A. Program equations and counterfactual inputs

The proportional allocation appears in `assemble_markets_fortran_mex.f90`, lines 212–228, and its derivative appears in `jac_assemble_markets.f90`, lines 244–263. The fixed reference is created in `bargaining_main.m`, lines 30–31, and its channel increments are formed in `sample_wtp.m`, lines 63–78. The focal channel is passed through `bargaining_nash_product.m`; the invoked Fortran evaluator uses scale 0.3, while the welfare source uses 0.2. The distributed downstream-equilibrium default sets channel prices to 1.1 times input cost. Footnote 39 of the article defines the Table 8 baseline at input cost and places the ten-percent margin in a robustness exercise. The distributed archive omits the saved counterfactual states used by these branches, so it cannot reproduce either calculation by itself.