Models of Household Behavior

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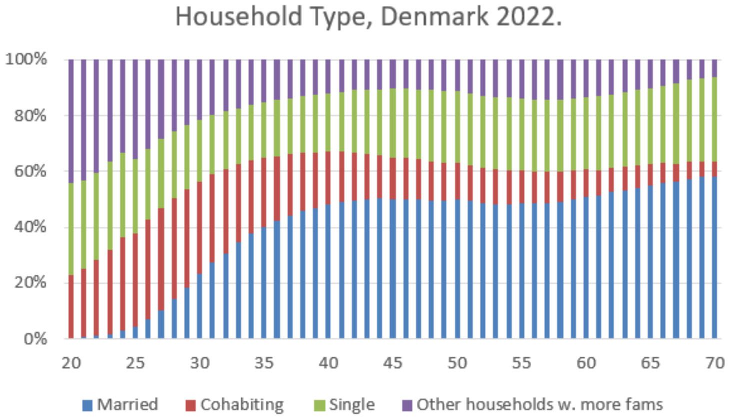
Empirical Motivation

- **Many people live in couples**



Introduction

- **Unitary model** until now
  The couple acted as one unit

- There are ∞ many ways of modeling household decisions
  Some large and some small differences
- I will focus on some main types of models
  Give an idea of the main similarities and differences
- My notation on dynamic models is different from Chiappori and Mazzocco (2017)

Outline

Production Technology

- **Superscript:** individual (1,2), **subscript:** element
- **Private** goods ($h = 1, \ldots, n$) produced as

$$q_h = q_h^1 + q_h^2 = f_h(x_h, d_h) \tag{1}$$

where
x_h: market goods inputs
$d_h = (d_h^1, d_h^2)$: time inputs

- **Public** goods ($k = 1, \ldots, N$) produced as

$$Q_k = F_k(X_k, D_k) \tag{2}$$

where
X_k: market goods inputs
$D_k = (D_k^1, D_k^2)$: time inputs

Preferences: Utility and Felicity Function

- Individual *utility* function

$$U^i(Q, q^1, q^2, l^1, l^2)$$

where
l^i is leisure time
$T^i = h^i + l^i + \sum_{k=1}^{N} D_k^i + \sum_{h=1}^{n} d_n^i$ is available time
h^i is hours worked

Preferences: Utility and Felicity Function

- **Caring preferences:**
  Care not about the allocation of partner but only their welfare:

$$U^i(Q, q^1, q^2, l^1, l^2) = W^i(u^1(Q, q^1, l^1), u^2(Q, q^2, l^2))$$

where
$u^i(Q, q^i, l^i)$ is called the *felicity* function

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  where
  $u^i(Q, q^i, l^i)$ is called the *felicity* function
- **Egotistic preferences:**
  Care not about the partner:
  $$U^i(Q, q^1, q^2, l^1, l^2) = F^i(u^i(Q, q^i, l^i), a)$$
  where a can contain marital status etc.

Budget Constraint

- **Budget constraint**

$$p'\left(\sum_{k=1}^{N} X_k + \sum_{h=1}^{n} x_n\right) = \sum_{i=1}^{2}(y^i + w^i h_i) \tag{3}$$

where
p is vector of market prices
y^i is non-market income.
w^i is wage rate

- Can be written as in Chiappori and Mazzocco (2017)

$$p'\left(\sum_{k=1}^{N} X_k + \sum_{h=1}^{n} x_n\right) + \sum_{i=1}^{2} w^i(l^i + \sum_{k=1}^{N} D_k^i + \sum_{h=1}^{n} d_n^i) = \underbrace{\sum_{i=1}^{2}(y^i + w^i T^i)}_{Y \text{ (pot. inc.)}}$$

(note that $T^i = h^i + l^i + \sum_{k=1}^{N} D_k^i + \sum_{h=1}^{n} d_n^i$, they miss l^i on p. 989)

- **Income pooling:** non-labor income, y^i, enters identically for both

Unitary Model

- **Unitary model**, households solve (conditional on $Y = \sum_{i=1}^{2}(y^i + w^i T^i)$)

$$\max_{X,x,l^1,l^2,d^1,d^2,D^1,D^2} U^H(Q, q, l^1, l^2)$$

$$\text{s.t.}$$

$$Q_k = F_k(X_k, D_k),\ k = 1, \dots, N$$

$$q_h = q_h^1 + q_h^2 = f_h(x_h, d_h),\ h = 1, \dots, n$$

$$Y = p'\left(\sum_{k=1}^{N} X_k + \sum_{h=1}^{n} x_h\right) + \sum_{i=1}^{2} w^i(l^i + \sum_{k=1}^{N} D_k^i + \sum_{h=1}^{n} d_n^i)$$

where $U^H(Q, q, l^1, l^2)$ is *some* household-level utility function

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  where $U^H(Q, q, l^1, l^2)$ is *some* household-level utility function
- **Rationalized** via
  Samuelson's welfare index
  Becker's rotten kid (famous, but we skip)
  Transferable Utility (TU)

Unitary Motivation: Samuelson's welfare index

- **Samuelson's welfare index**

$$U^H(Q, q, I^1, I^2) = \max_{q_1, q_2} W(u^1(Q, q^1, I^1), u^2(Q, q^2, I^2))$$

$$\text{s.t.}$$

$$q = q_1 + q_2$$

- **Example** could be

$$W(u^1(Q, q^1, I^1), u^2(Q, q^2, I^2)) = \lambda u^1(Q, q^1, I^1) + (1 - \lambda)u^2(Q, q^2, I^2)$$

  where
  λ is a constant weight on each member's utility; "power"

- **Arbitrary** that households should have some $W()$... but
  this example is a special form of the "collective model" below [nice]

Unitary Motivation: Transferable Utility

- **If there exists a Pareto frontier**,
  such that a *cardinal transformation,* $k()$ gives
  $$k(u^1(Q,q^1,l^1)) + k(u^2(Q,q^2,l^2)) = K(p,w,Y)$$
  $\rightarrow$ utility possibility frontier has a slope of -1,
  $$k(u^1(Q,q^1,l^1)) = K(p,w,Y) - k(u^2(Q,q^2,l^2))$$
- **Then** we can describe the optimization problem using $U^H(Q,q,l^1,l^2)$

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- **Then** we can describe the optimization problem using $U^H(Q,q,l^1,l^2)$
- **Example:** Conditional on Y,
$$U^{m\star}(\overline{u}^f) = \max_{c^m} U^m(c^m) = \sqrt{c^m}$$
$$\text{s.t.}$$
$$Y = c^m + c^f$$
$$\overline{u}^f = U^f(c^f) = \sqrt{c^f}$$
gives $U^{m\star}(\overline{u}^f)^2 = \text{constant}(Y) - (\overline{u}^f)^2$.

Unitary Model: Not Consistent with Data

- **Two testable implications**
  1. Income pooling (source of non-labor income does not matter for behavior)
  2. Slutsky symmetry (commodity prices affect members' demand similarly)

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- **Almost always rejected** see Chiappori and Mazzocco (2017, p. 1022)

- **Alternatives** have been proposed
  Non-cooperative
  Cooperative (collective)

Non-Cooperative

- **Non-cooperative models:**
  A game with two players
  Nash equilibrium

$$\max_{Q^1, q^1, l^1} u^1(Q^1 + Q^2, q^1, q^2, l^1, l^2)$$

$$\text{s. t.}$$

$$PQ^1 + p'q^1 = Y^1$$

and

$$\max_{Q^2, q^2, l^2} u^2(Q^1 + Q^2, q^1, q^2, l^1, l^2)$$

$$\text{s. t.}$$

$$PQ^2 + p'q^2 = Y^2$$

- **Generally not efficient:** Partner's gains not internalized.

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  Typically formulated as

$$\max_{X,x,l^1,l^2,d^1,d^2,D^1,D^2} \lambda(z)u^1(Q,q^1,l^1) + (1-\lambda(z))u^2(Q,q^2,l^2)$$

s.t.

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$$Y = p'\left(\sum_{k=1}^{N} X_k + \sum_{h=1}^{n} x_h\right) + \sum_{i=1}^{2} w^i(l^i + \sum_{k=1}^{N} D_k^i + \sum_{h=1}^{n} d_n^i)$$

- **Distribution factors:** z
  Anything that affect power, such as p, w, y.
  Cannot be endogenous: Over-investment in power $\rightarrow$ inefficient.

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- **Distribution factors:** z
  Anything that affect power, such as p, w, y.
  Cannot be endogenous: Over-investment in power $\rightarrow$ inefficient.
- **Unitary model** is nested, $\lambda(z) = \text{constant} \rightarrow$ unitary model

Outline

1. Static Models
   - Setting
   - Unitary Model
   - Non-cooperative
   - Cooperative: Collective

2. Dynamic Models
   - Full Commitment
   - Limited Commitment

Dynamic Models

- All comes down to how the bargaining weight is updated.
- My slides combine Chiappori and Mazzocco (2017)
  with Theloudis, Velilla, Chiappori, Giménez-Nadal and Molina (2022)
  and own lecture note

General Setup: Choices

- Period $t = 0$: Individual A and B become a couple
- Periods $t > 0$: As a couple, they decide on
  - private consumption, c_t^A and c_t^B (and thus savings, a_t)
  - labor supply, $l_t^A, l_t^B \in \{0, 0.75, 1\}$
  - whether to split up (no re-partnering for simplicity)
- Period T: both die with certainty

- **Inter-temporal budget** constraint of couple

$$a_t + c_t^A + c_t^B = Ra_{t-1} + w^A l_t^A + w^B l_t^B$$

with $a_t \geq 0 \ \forall t$. Will leave this out in couples problem.

General Setup: Utility

- **Individual utility** is for $j \in \{A, B\}$

$$u^j(c_t^j, l_t^j)$$

- **Household utility** is weighted sum

$$U(c_t^A, c_t^B, l_t^A, l_t^B; \psi_t, \mu_t) = \mu_t u^A(c_t^A, l_t^A) + (1 - \mu_t) u^B(c_t^B, l_t^B) + \psi_t$$

where match quality/"love" is

$$\psi_t = \psi_{t-1} + \varepsilon_t, \; \varepsilon \sim iid\mathcal{N}(0, \sigma_\varepsilon^2)$$

and μ_t is the **bargaining power** of agent A

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- How μ_t is determined defines the different types of models:
Unitary: $\mu_t = \mu$ is a **constant number**
Full commitment: $\mu_t = \mu_0(Z)$ is a **constant function** (of initial states)
No commitment: μ_t is updated in each period
Limited commitment: $\mu_t = \mu_t(\bullet, \mu_{t-1})$ is a function of past power

General Setup: Recursive Formulation

- **Outside option:** Value of being single

$$V_t^j(a_{t-1}) = \max_{c_t^j, l_t^j} u^j(c_t^j, l_t^j) + \beta V_{t+1}^j(a_t)$$

$$\text{s.t.}$$

$$a_t = Ra_{t-1} + w^j l_t^j - c_t^j$$

where I do not allow for re-partnering.

- **Non-cooperation** could be outside option

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- **Non-cooperation** could be outside option
- **Partnership dissolution:**
  A share λ of total wealth is transferred to agent A and $1-\lambda$ to agent B.
  $a_t^A = \lambda a_t$ and $a_t^B = (1-\lambda)a_t$
- **Value of being in a couple**
  depends on what we assume about the *bargaining process*.

Unitary Model

- **Constant** bargaining power, $\mu_t = \mu$.
- **Value of a couple** is

$$W_t(a_{t-1}, \psi_t) = \max_{c_t^A, c_t^B, l_t^A, l_t^B} U(c_t^A, c_t^B, l_t^A, l_t^B, \psi_t; \mu) + \\ + \beta \tilde{W}_{t+1}(a_t, \psi_t)$$

the *expected continuation* value is

$$\tilde{W}_{t+1}(a_t, \psi_t) \\ = \mathbb{E}_t[\max\{W_{t+1}(a_t, \psi_{t+1}) \; ; \; \underbrace{\mu V_{t+1}^A(a_t^A) + (1-\mu) V_{t+1}^B(a_t^B)}_{\text{weighted value of singlehood}}\}]$$

Commitment Models

- **Endogenously determined μ_t**
  - FC: Full commitment, μ_t is a **constant function**
    We will see in Bruze, Svarer and Weiss (2015)
  - NC: No commitment, μ_t updated **every period**
    We will just discuss today
  - LC: Limited commitment, μ_t updated **sometimes** $\rightarrow$ function of past power
    We will see in several papers + code

Full Commitment

- Bargaining power function is determined and agreed upon **at beginning of partnership**
- Bargaining power is thus a *constant function*

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  - Assume that couples can **commit** to this bargaining power function
  - Will e.g. not request more bargaining power from (changes in) something not in Z_t
  - If time-varying elements in Z_t: Assuming perfect foresight

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  - Will e.g. not request more bargaining power from (changes in) something not in Z_t
  - If time-varying elements in Z_t: Assuming perfect foresight
- **How is this function determined?**
  We will come back to this in a few slides

Full Commitment

- **Value of being a couple** is then

$$W_t(a_{t-1},\psi_t) = \max_{c_t^A, c_t^B, l_t^A, l_t^B} U(c_t^A, c_t^B, l_t^A, l_t^B; \psi_t, \mu_0(Z_t)) + \beta \tilde{W}_{t+1}(a_t, \psi_t)$$

where *expected continuation* value is

$$\tilde{W}_{t+1}(a_t,\psi_t) = \mathbb{E}_t[\max\{W_{t+1}(a_t,\psi_{t+1}) \\ ; \underbrace{\mu_0(Z_{t+1})V_{t+1}^A(a_t^A) + (1-\mu_0(Z_{t+1}))V_{t+1}^B(a_t^B)}_{\text{weighted value of singlehood}}\}]$$

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- **Transferable utility:** Household jointly decide to divorce if

$$W_{t+1}(a_t) < \mu_{t+1}V_{t+1}^A(a_t^A) + (1-\mu_{t+1})V_{t+1}^B(a_t^B)$$

- No constraints on individual members' utilities

Full Commitment: Determining Bargaining Power

- How could the bargaining power be determined?

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- How could the bargaining power be determined?
- **Idea 1: Nash-bargaining** at the point of partnership formation

$$\mu_0(Z) = \arg\max_{\mu \in [0,1]} \left(\mu W_0(a_{-1}) - V_0^A(\lambda a_{-1})\right)^{0.5} \times \left((1-\mu) W_0(a_{-1}) - V_0^B((1-\lambda) a_{-1})\right)^{0.5}$$

  - μ_0 "non-parametric" constant function of e.g. $Z = (a_{-1}, w_0^A, w_0^B)$

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- **Idea 2: Assume a functional form** (Bruze, Svarer and Weiss, 2015)

$$\mu_0(w_t^A/w_t^B) = \frac{\exp(\alpha_0 + \alpha_1 w_t^A/w_t^B)}{1+\exp(\alpha_0 + \alpha_1 w_t^A/w_t^B)}$$

and estimate parameters α_0 and α_1 using data.

  - If $\alpha_1 = 0$: Similar to the unitary model.

No- and Limited Commitment

- My definition of "No commitment" is different from that of Mazzocco (2007)
  - I will call his setup "Limited commitment" (as is standard now)
- They are closely related: Both **do not assume transferable utility**
  - Only differ in how the bargaining power is updated dynamically
- We thus need to check **individual "participation" constraints**: Is it optimal for each agent to be part of the couple without receiving any utility from the other partner
- We need to define a new object for this purpose: The value of agent j from being in the couple if μ_{t-1} is the bargaining power coming into period t **TODO: this household value does not really have a big role...**

$$W_t^j(a_{t-1}^j, \psi_t, \mu_{t-1})$$

(we will derive this in a few slides)

Recursive Formulation

- **Individual value of choice** while in a couple is

$$v_t^j(c_t^j, l_t^j; a_{t-1}, \psi_t, \tilde{\mu}) = u^j(c_t^j, l_t^j) + \psi_t + \beta \mathbb{E}_t[W_{t+1}^j(a_t^j, \psi_{t+1}, \tilde{\mu})]$$

where $\tilde{\mu}$ is *some* bargaining power, we will discuss in great detail.

  - μ_{t-1} is the value when entering period t (the state)

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  I will omit the dependence on other state variables than μ

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1. **Conditional on remaining together**, optimal choices are

$$\tilde{c}_t^A(\tilde{\mu}), \tilde{c}_t^B(\tilde{\mu}), \tilde{l}_t^A(\tilde{\mu}), \tilde{l}_t^B(\tilde{\mu}) = \arg \max_{c_t^A, c_t^B, l_t^A, l_t^B} \tilde{\mu} v_t^A(c_t^A, l_t^A; a_{t-1}, \psi_t, \tilde{\mu}) + (1 - \tilde{\mu}) v_t^B(c_t^B, l_t^B; a_{t-1}, \psi_t, \tilde{\mu})$$

Recursive Formulation

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2. **Marital surplus** for agent j is

$$S_t^j(\tilde{\mu}) = v_t^j(\tilde{c}_t^j(\tilde{\mu}), \tilde{l}_t^j(\tilde{\mu}); a_{t-1}, \psi_t, \tilde{\mu}) - V_t^j(a_{t-1}^j)$$

Limited Commitment

3. If $S_t^A(\mu_{t-1}) \geq 0$ and $S_t^B(\mu_{t-1}) \geq 0$ then $\mu_t^\star = \mu_{t-1}$ (no change)
   If $S_t^A(\mu_{t-1}) < 0$ then $\mu_t^\star : S_t^A(\mu_t^\star) = 0$, and similarly if $S_t^B(\mu_{t-1}) < 0$

Limited Commitment

3. If $S_t^A(\mu_{t-1}) \geq 0$ and $S_t^B(\mu_{t-1}) \geq 0$ then $\mu_t^\star = \mu_{t-1}$ (no change)
   If $S_t^A(\mu_{t-1}) < 0$ then $\mu_t^\star : S_t^A(\mu_t^\star) = 0$, and similarly if $S_t^B(\mu_{t-1}) < 0$

4. If $S_t^A(\mu_t^\star) \geq 0$ and $S_t^B(\mu_t^\star) \geq 0$, set $\mu_t = \mu_t^\star$ and

$$W_t^j(a_{t-1}^j, \psi_t, \mu_{t-1}) = \mu_t v_t^A(c_t^A(\mu_t), l_t^A(\mu_t); a_{t-1}, \psi_t, \mu_t) + (1-\mu_t) v_t^B(c_t^B(\mu_t), l_t^B(\mu_t); a_{t-1}, \psi_t, \mu_t)$$

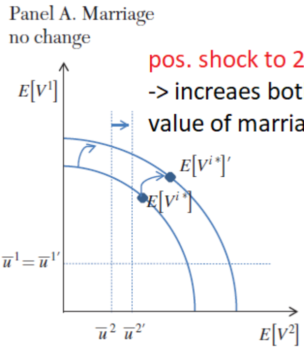
   Else, couple divorce and

$$W_t^j(a_{t-1}^j, \psi_t, \mu_{t-1}) = \mu_{t-1} V_t^A(a_{t-1}^A) + (1-\mu_{t-1}) V_t^B(a_{t-1}^B)$$

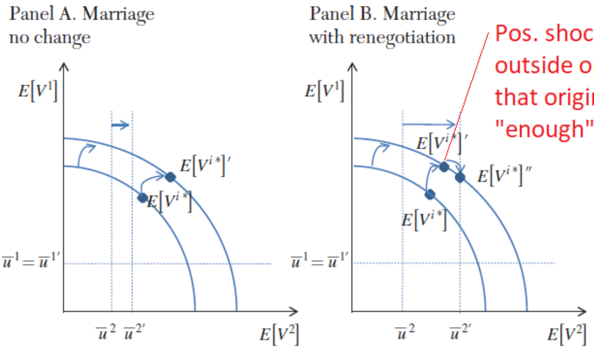
Limited Commitment: Updating Bargaining Weight

pos. shock to 2: e.g. wage raise

-> increaes both outside option and value of marriage

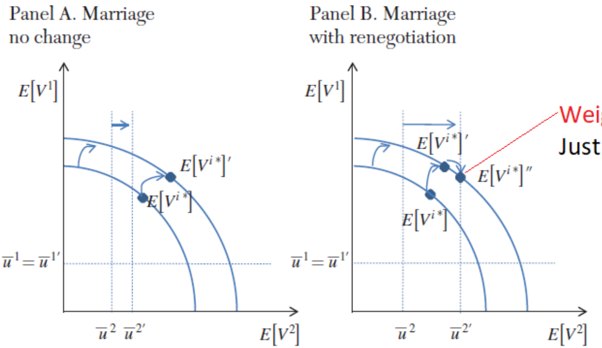


Limited Commitment: Updating Bargaining Weight



Pos. shock to 2: Increases outside option so much that original "power" not "enough" to stay

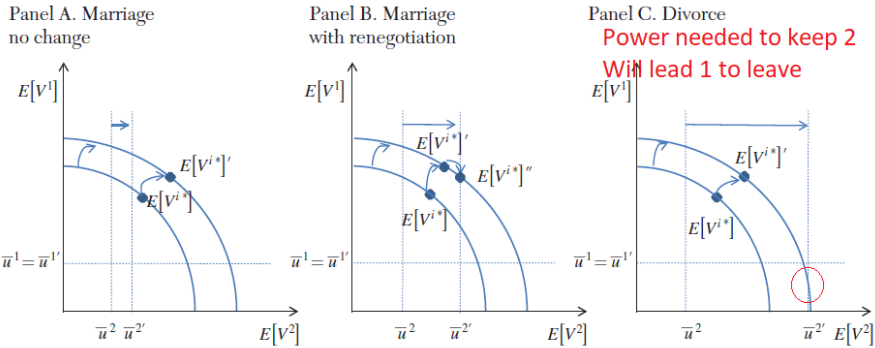
Limited Commitment: Updating Bargaining Weight



Weight for 2 is increased

Just enough to be indifferent

Limited Commitment: Updating Bargaining Weight



No Commitment

- **Limited commitment:** Bargaining power updated if individual participation constraints violated at current bargaining position, μ_{t-1},

$$\mu_t = \mu_t^{\star}(a_{t-1}, \psi_t, \mu_{t-1})$$

No Commitment

- **Limited commitment:** Bargaining power updated <u>if</u> individual participation constraints violated at current bargaining position, μ_{t-1},

$$\mu_t = \mu_t^\star(a_{t-1}, \psi_t, \mu_{t-1})$$

- **No commitment:** Bargaining power updated in *all periods*,

$$\mu_t = \mu_t^\star(a_{t-1}, \psi_t)$$

  replace step 3 with e.g. [instead of the discussion before]

$$\mu_t = \arg\max_{\tilde{\mu}} S_t^A(\tilde{\mu})^{0.5} S_t^B(\tilde{\mu})^{0.5}$$

- **We focus on limited commitment** in the code
  What about initial bargaining power, μ_0, then?
  Could be found through Nash bargaining :)

Next Time

- **Next time:**
  Divorce Laws, Savings and Labor Supply.

- **Literature:**
  Voena (2015): "Yours, Mine, and Ours: Do Divorce Laws Affect the Intertemporal Behavior of Married Couples?"
  - **Read** before lecture
  - **Reading guide:**
    Section 0: Introduction. Key
    Section 1: US divorce law. Key.
    Section 2: Model. *Key*, but complex. Get the idea.
    Under unilateral divorce: limited commitment model.
    Section 3: Data and RF motivation. Get the overall results/motivation.
    Section 4: Structural Estimation: Read fast.
    Section 5: Counterfactual simulations. Key.

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