Does Home Production Drive Structural Transformation?

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- Many papers emphasize the role of home production for structural transformation
- Rogerson (2008): European countries have a smaller service sector share than the U.S.
    1. Higher labor income tax discourages people to work in markets
    2. Home-produced services substitute market services
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  - Evaluate the performance of the 3-sector model (agriculture, manufacturing, services) with the data
  - Quantify each impact of different driving forces on structural transformation
- No modeling of home production
- This paper estimates a structural tansformation model with a home production sector

Motivation: Literature 2

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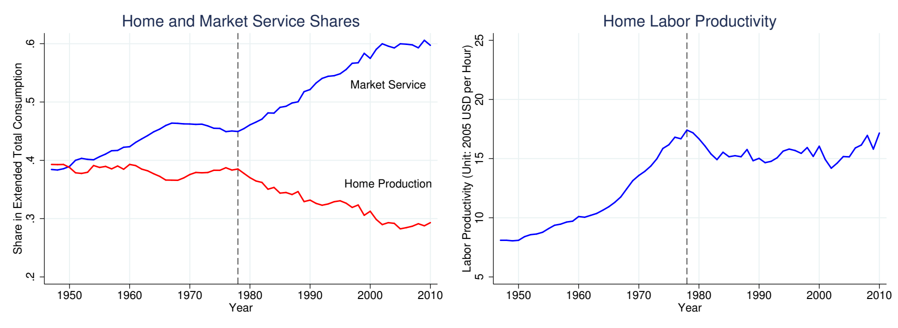

Home production data from Bridgman (2013)

- Around 1978,
  - Market services grew faster
  - Home production declined
  - Home labor productivity stopped growing

- Propose a parsimonious model of structural transformation with a home production sector
  1. Differential productivity growth in each sector; Ngai and Pissarides (2007)
  2. Non-homothetic preferences; Kongsamut, Rebelo, and Xie (2001)
- Estimate the model for the U.S. using the new home production data by Bridgman (2013)
  - Compare the implications of alternative preference specifications
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Model

- The model is a simple multi-sector growth model
- Time: Discrete, $t = 0, 1, 2, \ldots$
- Household: A representative household
- Five types of goods (and sectors):
  1. Agricultural good: c_t^a
  2. Manufacturing good: c_t^m
  3. Market services: c_t^{sm}
  4. Home services: c_t^{sh} (as if operated by a market firm!)
  5. Investment good: x_t
- Firm: A perfectly competitive firm in each sector

Non-Homothetic Preference:

- Household's preferences are given by

$$u = \sum_{t=0}^{\infty} \beta^t \ln C_t$$

$$C_t = \left((\omega^a)^{\frac{1}{\sigma}} \left(c_t^a + \bar{c}^a\right)^{\frac{\sigma-1}{\sigma}} + (\omega^m)^{\frac{1}{\sigma}} \left(c_t^m + \bar{c}^m\right)^{\frac{\sigma-1}{\sigma}} + (\omega^s)^{\frac{1}{\sigma}} \left(c_t^s + \bar{c}^s\right)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

$$c_t^s = \left[\psi (c_t^{sm})^{\frac{\gamma-1}{\gamma}} + (1-\psi)(c_t^{sh} + \bar{c}^{sh})^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}}$$

Differential Growth of Technological Change:

- For the consumption sector j $(\in \{a, m, sm, sh\})$, production is given by;

$$Y^j = A_t^j \left(K_t^j\right)^{\alpha} \left(L_t^j\right)^{1-\alpha},$$

- For the investment good sector, it is given by

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We can write the household problem as

$$\max \sum_{t=0}^{\infty} \beta^t \ln C_t \tag{P1}$$

subject to

$$C_t = \left(\sum_{i=a,m,s} \left(\omega^i\right)^{\frac{1}{\sigma}} \left(c_t^i + \bar{c}^i\right)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

$$c_t^s = \left[\psi (c_t^{sm})^{\frac{\gamma-1}{\gamma}} + (1-\psi)(c_t^{sh} + \bar{c}^{sh})^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}}$$

$$p_t^a c_t^a + p_t^m c_t^m + p_t^{sm} c_t^{sm} + p_t^{sh} c_t^{sh} + k_{t+1} - (1-\delta)\, k_t = r_t k_t + w_t \bar{l}$$

1. Inter-Temporal Problem:

$$\max_{\{C_t, k_{t+1}\}} \sum_{t=0}^{\infty} \beta^t \ln C_t \tag{P2}$$

$$\text{s.t.} \qquad P_t C_t + k_{t+1} - (1-\delta) k_t = r_t k_t + w_t \bar{l} + p_t^{sh} \bar{c}^{sh} + \sum_{i=a,m,s} p_t^i \bar{c}^i$$

where $P_t \equiv \left[\sum_i \omega^i \left(p_t^i \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$, $p_t^s \equiv \left[\psi^\gamma \left(p_t^{sm} \right)^{1-\gamma} + (1-\psi)^\gamma \left(p_t^{sh} \right)^{1-\gamma} \right]^{\frac{1}{1-\gamma}}$

2. Intra-Temporal Problem:

$$\max_{\{c_t^a, c_t^m, c_t^{sm}, c_t^{sh}\}} \left(\sum_{i=a,m,s} \left(\omega^i \right)^{\frac{1}{\sigma}} \left(c_t^i + \bar{c}^i \right)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \tag{P3}$$

$$\text{s.t.} \qquad c_t^s = \left[\psi (c_t^{sm})^{\frac{\gamma-1}{\gamma}} + (1-\psi)(c_t^{sh} + \bar{c}^{sh})^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}}$$

$$p_t^a c_t^a + p_t^m c_t^m + p_t^{sm} c_t^{sm} + p_t^{sh} c_t^{sh} = P_t C_t - \sum_{i=a,m,s} p_t^i \bar{c}^i - p_t^{sh} \bar{c}^{sh} \equiv E_t$$

where E_t stands for the extended total consumption expenditure

- We only solve and estimate the intra-temporal problem (P3)
  - As an alternative, Buera and Kaboski (2009) estimate (P1) in a general equilibrium framework using TFP data
- Advantages in focusing on only (P3);
  1. We can be agnostic about the investment sector
     - The investment sector is hard to model
  2. We are interested in estimating preference parameters
     - Given the separation of the two problems, it is sufficient to estimate (P3)

1. Value Added Consumption and Price Index from Herrendorf, Rogerson and Valentinyi (2013)
    - Compute value-added consumption from final consumption expenditure by using input-output matrix
    - Remove investment components in value-added consumption
2. Total Value Added from Bureau of Economic Analysis (BEA)
3. Value Added and Labor Productivity in Home Sector from Bridgman (2013)
    - We assume that home produced goods are not used for investment

Value Added Approach

$$(\text{Value Added at Home}) = w_t L_t^{sh} + \sum_{j=1}^{3} \left(r_t^j + \delta^j \right) Q_t^j$$

- L_t^{sh}: hours in household production from time use surveys
- w_t: hourly compensation of workers in the household sector
- Q_t^1, Q_t^2, Q_t^3: 1) consumer durables, 2) residential capital, and 3) governmental capital
- r_t^1, r_t^2, r_t^3: 1) households' financial asset returns, 2) imputed rents, and 3) government debt returns

- From the FOC in the home service sector, we have

$$p_t^{sh} = \frac{w_t}{(1-\alpha)\, A_t^{sh} \left(\frac{K_t^{sh}}{L_t^{sh}}\right)^{\alpha}} = \frac{(1-\alpha)\, EGDP_t}{(1-\alpha)\, A_t^{*sh}}$$

where $A_t^{*sh} \equiv \frac{Y_t^{sh}}{L_t^{sh}}$ is the labor productivity of the home sector

- For the last equation, we use

$$\underbrace{w_t}_{\text{wage}} = \underbrace{(1-\alpha) EGDP_t}_{\text{labor share}}$$

which is given by the assumption $L_t^a + L_t^m + L_t^{sm} + L_t^{sh} + L_t^x = \bar{l} = 1$.

- Given the set of parameters (we assume $\bar{c}^m = 0$)

$$\boldsymbol{\theta} \equiv \left(\sigma, \bar{c}^a, \bar{c}^s, \bar{c}^{sh}, \omega^a, \omega^m, \omega^s, \psi, \gamma\right),$$

- and given the set of (pre-determined) variables,

$$\mathbf{x}_t \equiv \left(p_t^a, p_t^m, p_t^{sm}, A_t^{*sh}, E_t, EGDP_t\right),$$

- the problem (P3) can be solved for the three shares as,

$$\frac{p_t^a c_t^a}{E_t} = f_1\left(\mathbf{x}_t; \boldsymbol{\theta}\right) + \epsilon_1,$$
$$\frac{p_t^m c_t^m}{E_t} = f_2\left(\mathbf{x}_t; \boldsymbol{\theta}\right) + \epsilon_2,$$
$$\frac{p_t^{sm} c_t^{sm}}{E_t} = f_3\left(\mathbf{x}_t; \boldsymbol{\theta}\right) + \epsilon_3.$$

- We employ iterated feasible generalized nonlinear least square (Deaton (1986) and Rogerson, Herrendorf and Valentinyi (2013))

Alternative Preference Specifications

- The literature (with a three-sector model);
    - Assumes $\bar{c}^a < 0$, $\bar{c}^m = 0$, and $\bar{c}^s > 0$ in the household's intra-temporal preference

$$C_t = \left((\omega^a)^{\frac{1}{\rho}} \left(c_t^a + \bar{c}^a\right)^{\frac{\sigma-1}{\sigma}} + (\omega^m)^{\frac{1}{\rho}} \left(c_t^m + \bar{c}^m\right)^{\frac{\sigma-1}{\sigma}} + (\omega^s)^{\frac{1}{\rho}} \left(c_t^{sm} + \bar{c}^s\right)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

- Kongsamut, Rebelo, and Xie (2001) interpret
    1. $\bar{c}^a < 0$: Subsistence level for food
    2. $\bar{c}^s > 0$: Home production

- Assume $\bar{c}^a < 0$, $\bar{c}^m = 0$, $\bar{c}^s = 0$ and $\bar{c}^{sh} = 0$

Model 1

$$C_t = \left((\omega^a)^{\frac{1}{\rho}} \left(c_t^a + \bar{c}^a\right)^{\frac{\sigma-1}{\sigma}} + (\omega^m)^{\frac{1}{\rho}} \left(c_t^m\right)^{\frac{\sigma-1}{\sigma}} + (\omega^s)^{\frac{1}{\rho}} \left(c_t^s\right)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

$$c_t^s = \left[\psi (c_t^{sm})^{\frac{\gamma-1}{\gamma}} + (1-\psi)(c_t^{sh})^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}}$$

- Given an explicit home good in preference, $\bar{c}^s$ should be zero

- Used by Rogerson (2008), Ngai and Petrongolo (2014), and Rendall (2014)

- Assume $\bar{c}^a < 0$, $\bar{c}^m = 0$, $\bar{c}^s > 0$, and $\bar{c}^{sh} = 0$

Model 2

$$C_t = \left((\omega^a)^{\frac{1}{\rho}} (c_t^a + \bar{c}^a)^{\frac{\sigma-1}{\sigma}} + (\omega^m)^{\frac{1}{\rho}} (c_t^m)^{\frac{\sigma-1}{\sigma}} + (\omega^s)^{\frac{1}{\rho}} (c_t^s + \bar{c}^s)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

$$c_t^s = \left[\psi (c_t^{sm})^{\frac{\gamma-1}{\gamma}} + (1-\psi)(c_t^{sh})^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}}$$

- The term $\bar{c}^s > 0$ captures non-homotheticity in services, which is not explained by home production

- Assume $\bar{c}^a < 0$, $\bar{c}^m = 0$, $\bar{c}^s = 0$, and $\bar{c}^{sh} < 0$

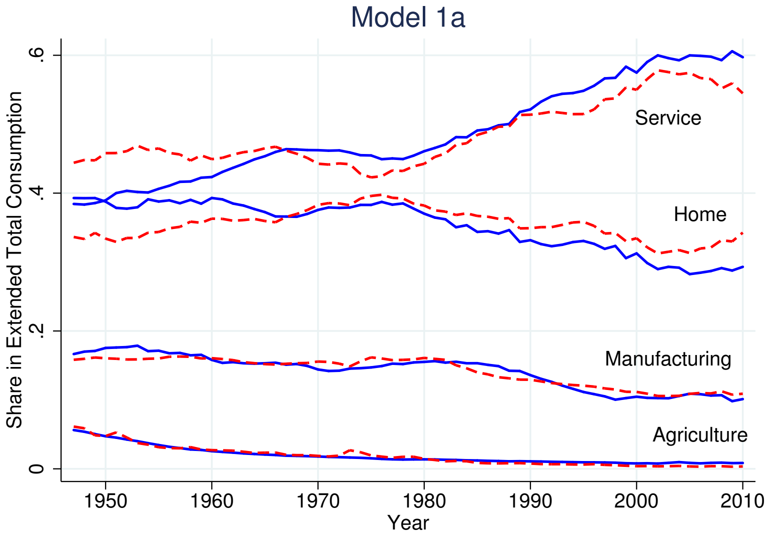
Model 3

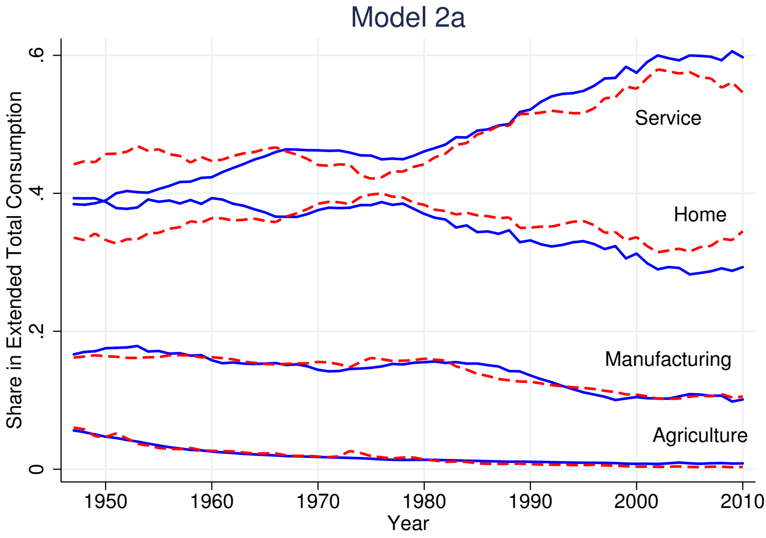
$$C_t = \left((\omega^a)^{\frac{1}{\rho}} (c_t^a + \bar{c}^a)^{\frac{\sigma-1}{\sigma}} + (\omega^m)^{\frac{1}{\rho}} (c_t^m)^{\frac{\sigma-1}{\sigma}} + (\omega^s)^{\frac{1}{\rho}} (c_t^s)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

$$c_t^s = \left[\psi (c_t^{sm})^{\frac{\gamma-1}{\gamma}} + (1-\psi)(c_t^{sh} + \bar{c}^{sh})^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}}$$

- The term $\bar{c}^{sh} < 0$ implies that the household initially needs a certain amount of home services
- As income grows, market services increases relative to home services
- Eichengreen and Gupta (2013): "The share of modern market services rises faster with income relative to that of more traditional market services which can be produced at home."

Results


Model 1a
Share in Extended Total Consumption
0
.2
.4
.6
1950
1960
1970
1980
1990
2000
2010
Year
Service
Home
Manufacturing
Agriculture


Model 2a
Share in Extended Total Consumption
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.4
.6
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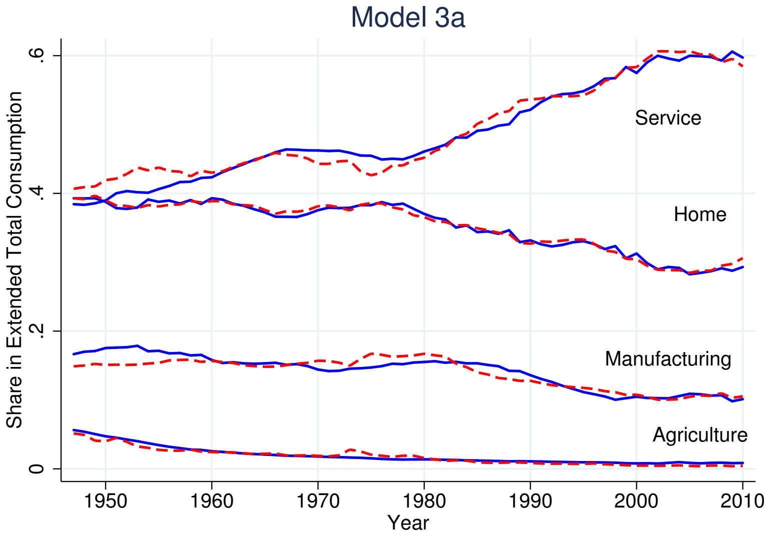
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Service
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Estimation Results Summary

	(1) 1a	(2) 2a	(3) 3a	(4) 3b	(5) 3c	(6) 3d
σ	0.2212**	0.1781**	0.0015	0.0006	0.0010	
	(0.0265)	(0.0276)	(0.0009)	(0.0012)	(0.0009)	
$\bar{c}^a$	-174.0990**	-171.9554**	-111.0453**	-134.5039**	-127.7640**	-107.6523**
	(4.0798)	(3.3737)	(4.8018)	(11.7211)	(9.5673)	(6.2414)
$\bar{c}^s$		562.9095**				
		(117.2384)				
$\bar{c}^{sh}$			-5462.3142**	-5016.4150**	-5497.1630**	-5374.0798**
			(102.6465)	(386.9034)	(156.6820)	(86.5952)
ω^a	0.0001	0.0000	0.0039**	0.0028**	0.0030**	0.0041**
	(0.0001)	(0.0001)	(0.0005)	(0.0010)	(0.0009)	(0.0006)
ω^m	0.1714**	0.1670**	0.1997**	0.1989**	0.2004**	0.1991**
	(0.0014)	(0.0017)	(0.0021)	(0.0024)	(0.0022)	(0.0021)
ω^s	0.8285**	0.8329**	0.7964**	0.7983**	0.7966**	0.7968**
	(0.0014)	(0.0017)	(0.0024)	(0.0030)	(0.0026)	(0.0024)
ψ	0.5712**	0.5710**	0.6107**	0.6366**	0.6179**	0.6099**
	(0.0020)	(0.0016)	(0.0011)	(0.0072)	(0.0019)	(0.0010)
γ	2.1180**	1.9992**	2.7357**			2.7450**
	(0.0763)	(0.0828)	(0.0331)			(0.0318)
N	64	64	64	64	64	64
AIC	-1272.7	-1266.7	-1438.1	-1268.5	-1374.1	-1440.7
BIC	-1234.8	-1222.5	-1393.9	-1230.6	-1336.2	-1402.8
$RMSE^a$	0.004	0.004	0.004	0.004	0.004	0.004
$RMSE^m$	0.009	0.008	0.011	0.011	0.011	0.011
$RMSE^s$	0.033	0.032	0.015	0.025	0.014	0.015
$RMSE^h$	0.029	0.030	0.005	0.027	0.011	0.005

- The data support different income elasticity between home and market services

1. The existing theories explain the movement of market and home only with differences in technologies: Ngai and Pissarides (2008) and Buera and Kaboski (2012a, 2012b)
   - Our results indicate changes in technologies are not enough to account for the movement in shares
2. Countries with different income levels naturally have different size of market and home services shares
   - A caution for cross-country analyses

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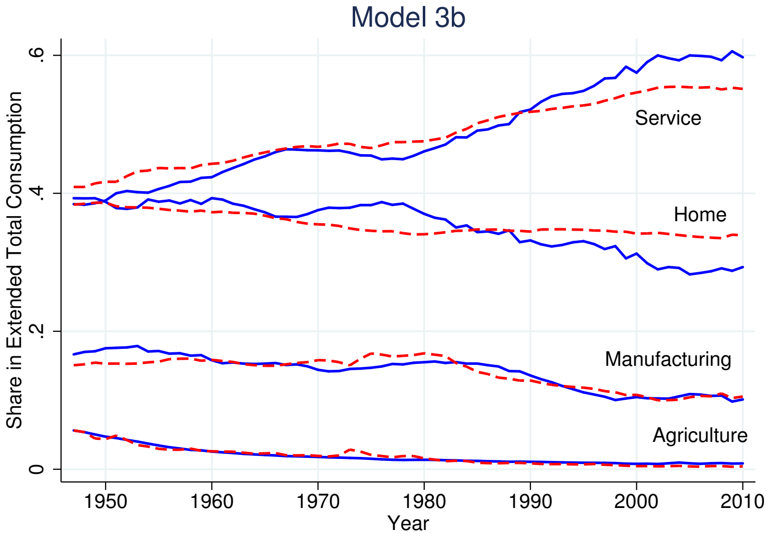
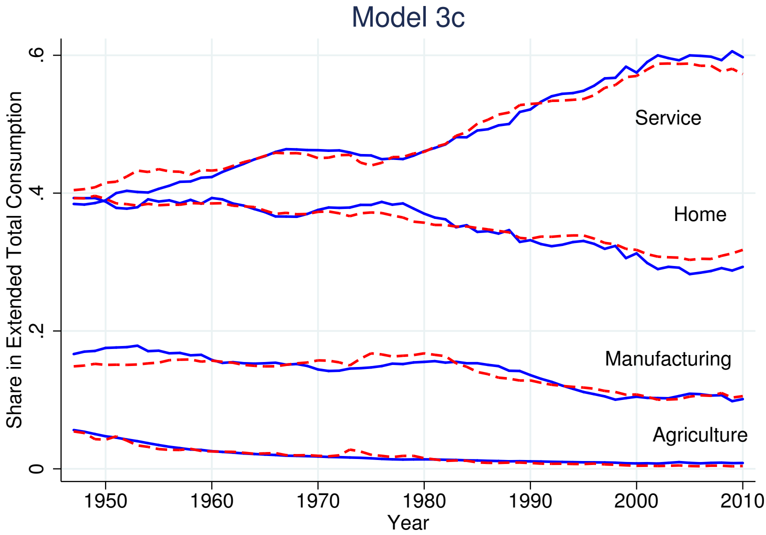
Fit of Model 3b ($\gamma = 1.5$)

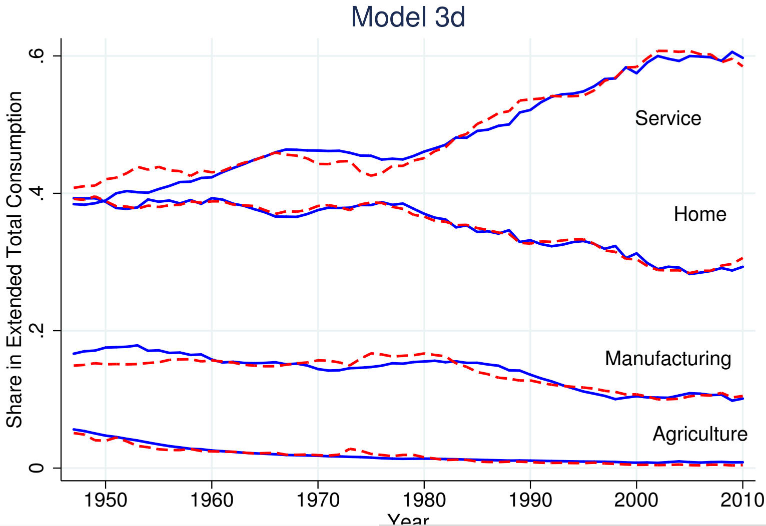


Fit of Model 3c ($\gamma = 2.3$)



- We obtain 2.75 for the parameter of the substitutability between market and home services
  1. Business cycles literature
     - McGrattan, Rogerson, and Wright (1997) find a value between 1.49 and 1.75. Chang and Schorfheide (2003) estimate it as 2.3
  2. Micro hours data literature
     - Rupert, Rogerson, and Wright (1995) find a value in the range between 1.60 and 2.00. Aguiar and Hurst (2006) estimate it as 1.80
- Our approach differs from these studies:
  1. Estimate substitutability between market services and home services (not between all market goods and home services)
  2. Exploit variations in sectoral shares when prices change

- Buera and Kaboski (2009), and Herrendorf, Rogerson, and Valentinyi (2013) also got a similar result for σ



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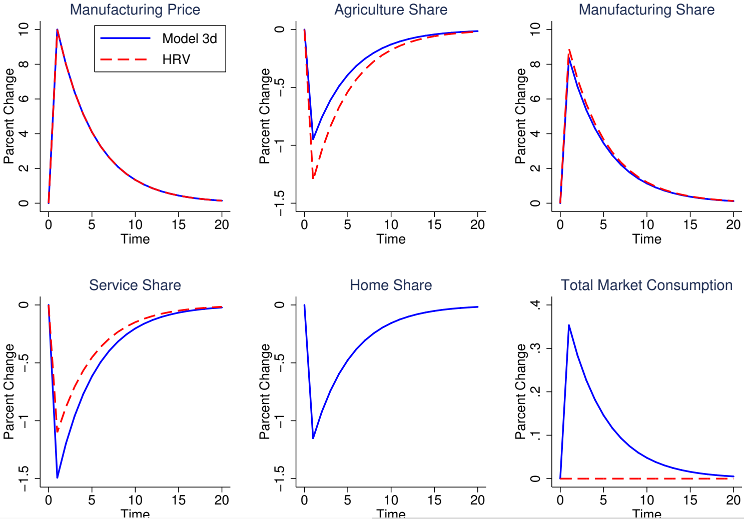
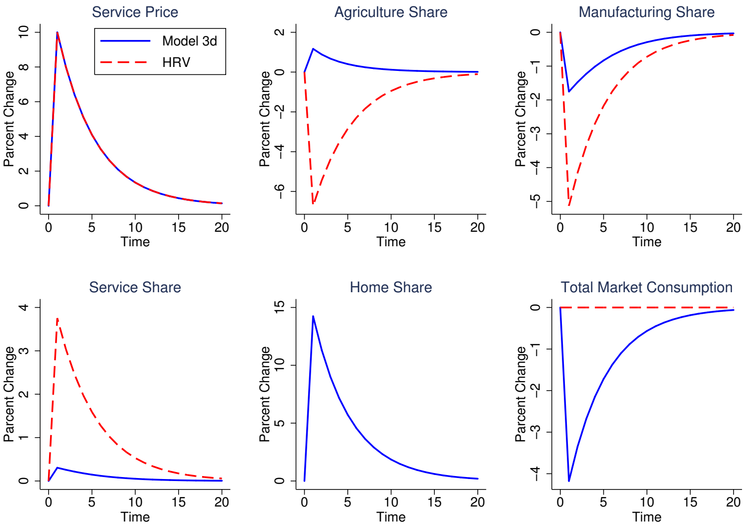
γ	2.1180**	1.9992**	2.7357**			2.7450**
	(0.0763)	(0.0828)	(0.0331)			(0.0318)
N	64	64	64	64	64	64
AIC	-1272.7	-1266.7	-1438.1	-1268.5	-1374.1	-1440.7
BIC	-1234.8	-1222.5	-1393.9	-1230.6	-1336.2	-1402.8
$RMSE^a$	0.004	0.004	0.004	0.004	0.004	0.004
$RMSE^m$	0.009	0.008	0.011	0.011	0.011	0.011
$RMSE^s$	0.033	0.032	0.015	0.025	0.014	0.015
$RMSE^h$	0.029	0.030	0.005	0.027	0.011	0.005

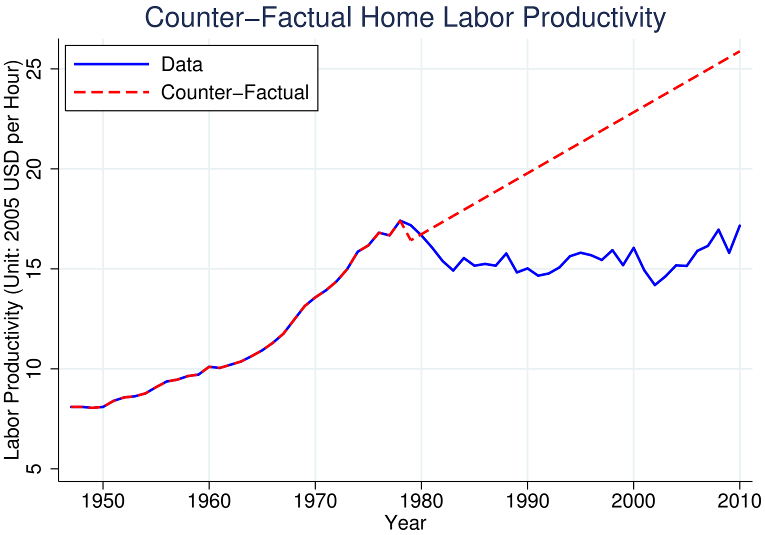
Counter-Factual Experiments

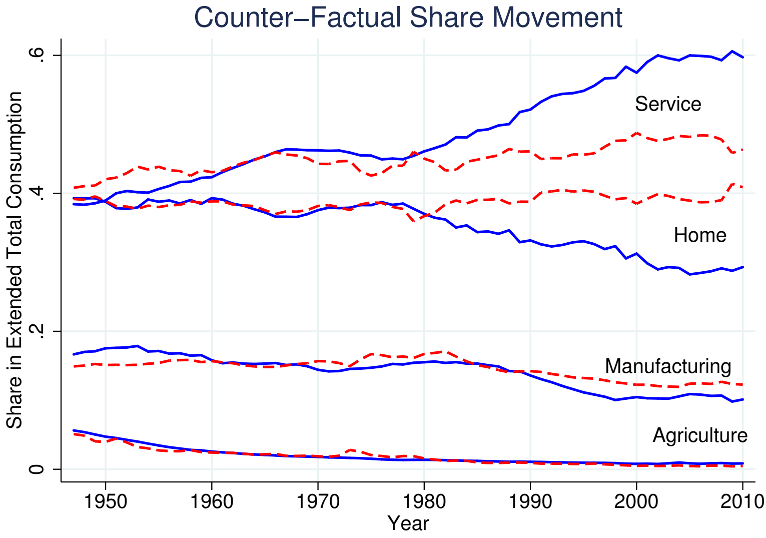
- Compare the results with HRV, which stands for Herrendorf, Rogerson and Valentinyi (2013) (a model without home production)




Service Price
Model 3d
HRV
Agriculture Share
Manufacturing Share
Service Share
Home Share
Total Market Consumption
Parcent Change
Time

- When a shock is to the service price
  - The household substitutes home services for market services, which mitigates the movement of other shares
  - Different movement of shares from Herrendorf, Rogerson and Valentinyi (2013)
- In the general equilibrium framework,
  - Our model predicts relocations of factors between market and home, but not across sectors
  - Lead to different policy implications from the existing model


Counter–Factual Home Labor Productivity
Data
Counter–Factual
Labor Productivity (Unit: 2005 USD per Hour)
5
10
15
20
25
1950
1960
1970
1980
1990
2000
2010
Year


Counter–Factual Share Movement
Share in Extended Total Consumption
0
.2
.4
.6
1950
1960
1970
1980
1990
2000
2010
Year
Service
Home
Manufacturing
Agriculture

	Ext. Consumption Share		Consumption Share		Consumption per Capita	
	Bench	Counter-Factual	Bench	Counter-Factual	Bench	Counter-Factual
Agriculture	0.0044	0.0048 (9.1%)	0.0063	0.0081 (28.6%)	255	279 (9.4%)
Manuf.	0.1049	0.1228 (17.1%)	0.1511	0.2077 (37.5%)	6097	7138 (17.1%)
Service	0.5848	0.4636 (-20.7%)	0.8425	0.7842 (-6.9%)	33992	26946 (-26.1%)
Home	0.3059	0.4089 (33.7%)	-	-	17783	23766 (33.6%)

- If the home productivity had been growing at 2.5% (as before 1978),

1. The market service share in total consumption expenditure would be lowered by 6.9% in 2010
2. Market services per capita would be lowered by 26.1%, instead home services per capita would be raised by 33.6% in 2010

Conclusion

- This paper:
  - Estimate a model of structural transformation with a home production sector using new home production data for the U.S.

- Three main findings;
  1. The popular specification of the model cannot fit the data
  2. The data support different income elasticity of market and home services
  3. The slowdown in home labor productivity in the late 70s accelerated the rise of market services

Future (or Ongoing) Work

1. Examination with detailed service categories
   - Services which substitute for home production
   - Others
2. Why did home labor productivity slow down?
3. International differences in home sector shares
   - Bridgman, Duernecker, and Herrendorf (2015)

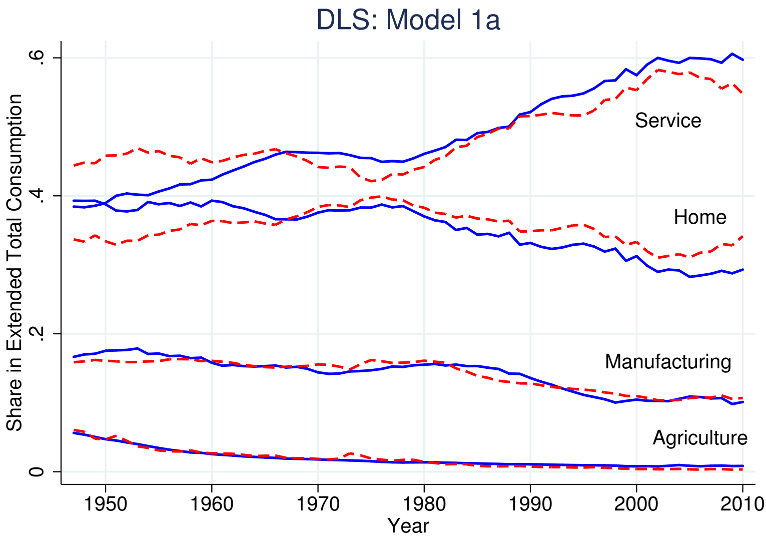
Robustness

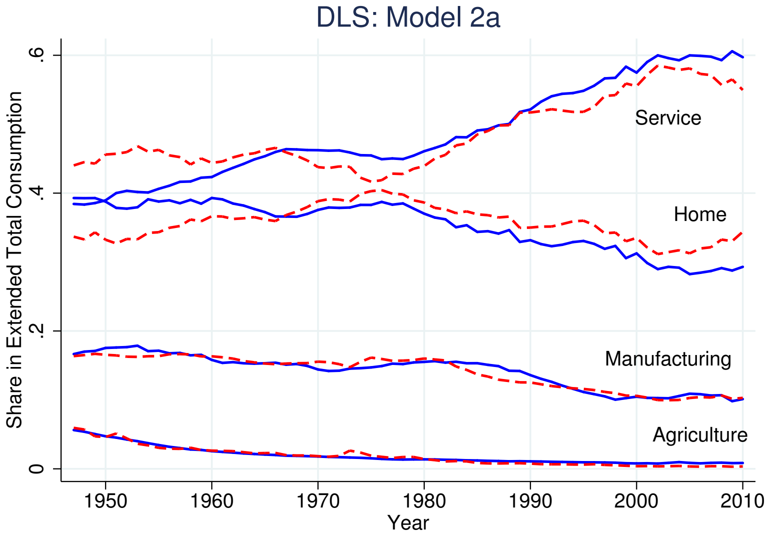
- We assume that the share parameter (α) is same between the market sectors and the home sector when deriving the price for home
- During the period, 1947 to 2010,
  - The mean labor share in GDP, $(1-\alpha^{mk})$, is 0.702
  - The mean labor share in the home sector, $(1-\alpha^{sh})$, is 0.632
- If we relax the assumption,

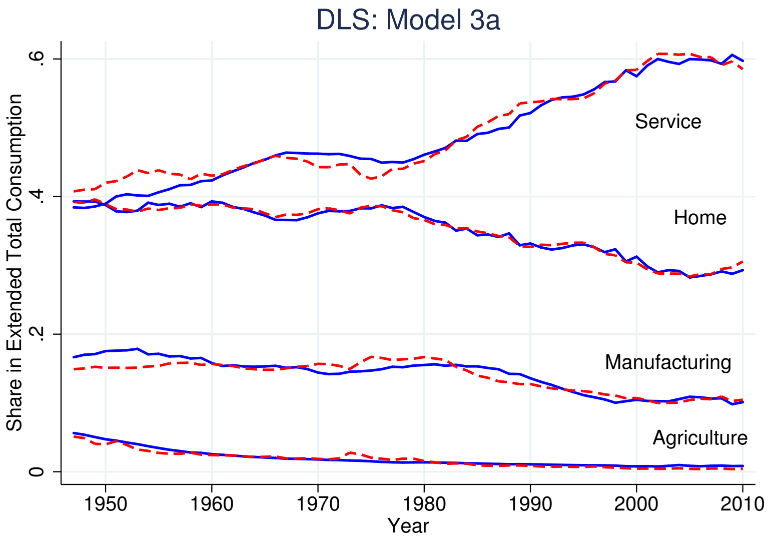
$$w_t = \left(1-\alpha^{mk}\right) GDP_t + \left(1-\alpha^{sh}\right) Y_t^{sh}$$

and

$$p_t^{sh} = \frac{\left(1-\alpha^{mk}\right) GDP_t + \left(1-\alpha^{sh}\right) Y_t^{sh}}{\left(1-\alpha^{sh}\right) A_t^{*sh}}$$


DLS: Model 1a
Share in Extended Total Consumption
0
.2
.4
.6
1950
1960
1970
1980
1990
2000
2010
Year
Service
Home
Manufacturing
Agriculture


DLS: Model 2a
Share in Extended Total Consumption
0
.2
.4
.6
1950
1960
1970
1980
1990
2000
2010
Year
Service
Home
Manufacturing
Agriculture

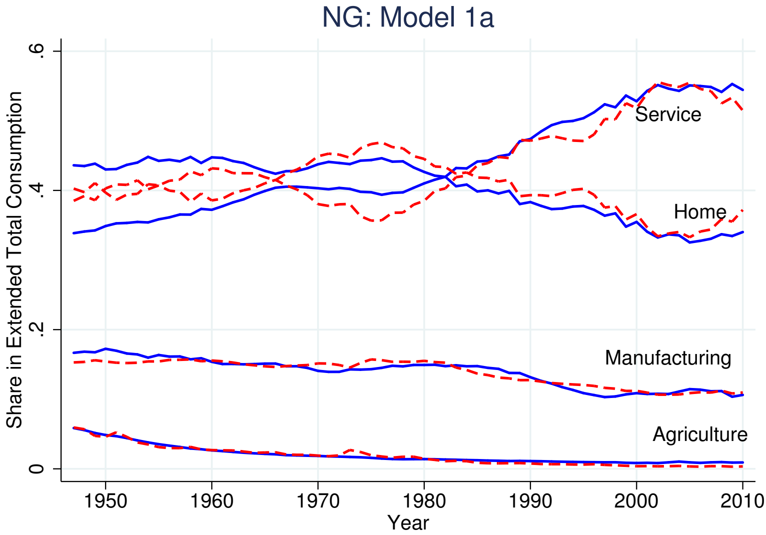

DLS: Model 3a
Share in Extended Total Consumption
0
.2
.4
.6
1950
1960
1970
1980
1990
2000
2010
Year
Service
Home
Manufacturing
Agriculture

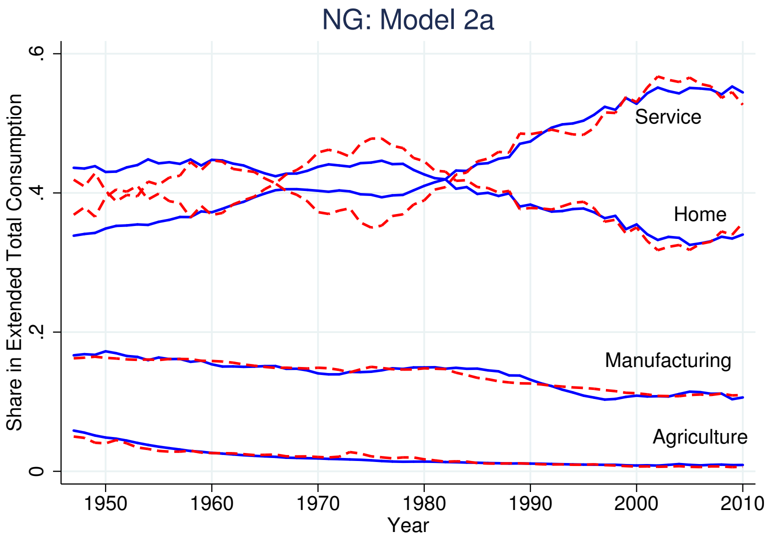
	(1) DLS: 1a	(2) DLS: 2a	(3) DLS: 3a	(4) DLS: 3d
σ	0.1872**	0.1434**	0.0003	
	(0.0306)	(0.0320)	(0.0007)	
$\bar{c}^a$	-170.9923**	-166.6319**	-109.5263**	-111.7382**
	(3.4615)	(6.3239)	(7.8216)	(6.0989)
$\bar{c}^s$		783.5226**		
		(141.9526)		
$\bar{c}^{sh}$			-5410.6116**	-5425.7228**
			(97.2150)	(95.8840)
ω^a	0.0002	0.0003	0.0040**	0.0038**
	(0.0002)	(0.0004)	(0.0007)	(0.0006)
ω^m	0.1716**	0.1653**	0.1989**	0.1991**
	(0.0015)	(0.0020)	(0.0021)	(0.0022)
ω^s	0.8282**	0.8344**	0.7972**	0.7970**
	(0.0015)	(0.0020)	(0.0025)	(0.0026)
ψ	0.5717**	0.5711**	0.6107**	0.6108**
	(0.0015)	(0.0013)	(0.0010)	(0.0010)
γ	2.1528**	2.0192**	2.7351**	2.7376**
	(0.0827)	(0.0965)	(0.0331)	(0.0297)
N	64	64	64	64
AIC	-1272.7	-1264.3	-1439.8	-1441.7
BIC	-1234.8	-1220.0	-1395.6	-1403.8
$RMSE^a$	0.004	0.004	0.004	0.004
$RMSE^m$	0.009	0.008	0.011	0.011
$RMSE^s$	0.032	0.031	0.015	0.015
$RMSE^h$	0.028	0.029	0.005	0.005

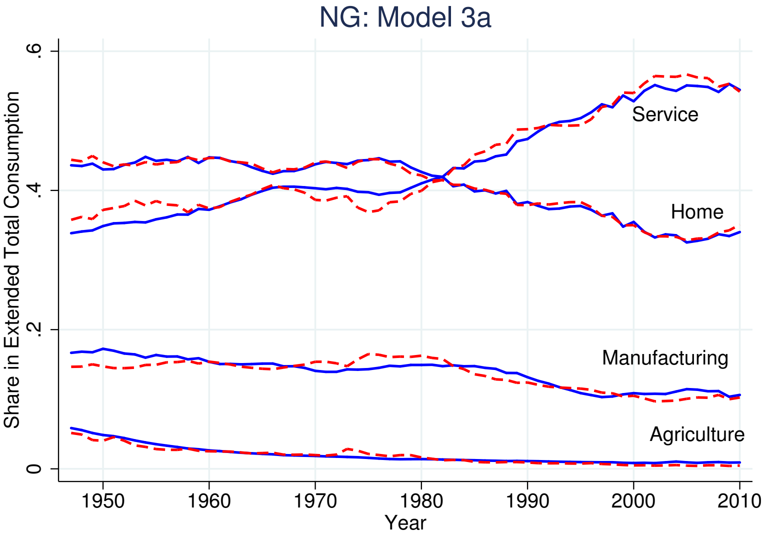
Robustness: Different Labor Shares

	Ext. Consumption Share		Consumption Share		Consumption per Capita	
	Bench	Counter-Factual	Bench	Counter-Factual	Bench	Counter-Factual
Baseline Result						
Agriculture	0.0044	0.0048 (9.1%)	0.0063	0.0081 (28.6%)	255	279 (9.4%)
Manuf.	0.1049	0.1228 (17.1%)	0.1511	0.2077 (37.5%)	6097	7138 (17.1%)
Service	0.5848	0.4636 (-20.7%)	0.8425	0.7842 (-6.9%)	33992	26946 (-26.1%)
Home	0.3059	0.4089 (33.7%)	-	-	17783	23766 (33.6%)
Different Labor Share						
Agriculture	0.0043	0.0047 (9.3%)	0.0062	0.0079 (27.4%)	250	271 (8.4%)
Manuf.	0.1049	0.1228 (17.1%)	0.1510	0.2071 (37.2%)	6097	7135 (17.0%)
Service	0.5853	0.4652 (-20.5%)	0.8427	0.7850 (-6.8%)	34020	27043 (-20.5%)
Home	0.3055	0.4073 (33.3%)	-	-	17759	23677 (33.3%)

- So far, we have assumed the government services are included in market services
- In reality, government consumption is externally imposed to the household
- For this reason, we re-estimate the model by removing the government sector both from consumption and from expenditure data
  1. We assume the household is taxed by the government to run a balanced budget, and
  2. The government spending does not provide utility to the household


NG: Model 1a
Share in Extended Total Consumption
0
.2
.4
.6
1950
1960
1970
1980
1990
2000
2010
Year
Service
Home
Manufacturing
Agriculture


NG: Model 2a
Share in Extended Total Consumption
0
.2
.4
.6
1950
1960
1970
1980
1990
2000
2010
Year
Service
Home
Manufacturing
Agriculture


NG: Model 3a
Share in Extended Total Consumption
0
.2
.4
.6
1950
1960
1970
1980
1990
2000
2010
Year
Service
Home
Manufacturing
Agriculture

	(1) NG: 1a	(2) NG: 2a	(3) NG: 3a	(4) NG: 3d
σ	0.3661**	0.4834**	0.1052**	
	(0.0277)	(0.0229)	(0.0190)	
$\bar{c}^a$	-152.8351**	-92.9442**	-101.4814**	-107.8409**
	(2.7966)	(7.1123)	(6.0650)	(6.8808)
$\bar{c}^s$		2774.3874**		
		(277.3434)		
$\bar{c}^{sh}$			-5566.9336**	-5703.8864**
			(166.1311)	(138.8104)
ω^a	0.0000	0.0053**	0.0042**	0.0034**
	(0.0000)	(0.0006)	(0.0007)	(0.0007)
ω^m	0.1587**	0.1332**	0.1883**	0.1921**
	(0.0019)	(0.0022)	(0.0021)	(0.0023)
ω^s	0.8413**	0.8615**	0.8075**	0.8044**
	(0.0019)	(0.0020)	(0.0023)	(0.0027)
ψ	0.5561**	0.5632**	0.5992**	0.6003**
	(0.0014)	(0.0012)	(0.0012)	(0.0012)
γ	2.2717**	1.7492**	2.5670**	2.5869**
	(0.0590)	(0.0600)	(0.0174)	(0.0198)
N	64	64	64	64
AIC	-1312.7	-1379.2	-1467.3	-1463.2
BIC	-1274.8	-1334.9	-1423.1	-1425.3
$RMSE^a$	0.004	0.004	0.004	0.004
$RMSE^m$	0.008	0.006	0.011	0.012
$RMSE^s$	0.027	0.023	0.014	0.014
$RMSE^h$	0.021	0.017	0.005	0.005

Robustness: No Government

	Ext. Consumption Share		Consumption Share		Consumption per Capita	
	Bench	Counter-Factual	Bench	Counter-Factual	Bench	Counter-Factual
Baseline Result						
Agriculture	0.0044	0.0048 (9.1%)	0.0063	0.0081 (28.6%)	255	279 (9.4%)
Manuf.	0.1049	0.1228 (17.1%)	0.1511	0.2077 (37.5%)	6097	7138 (17.1%)
Service	0.5848	0.4636 (-20.7%)	0.8425	0.7842 (-6.9%)	33992	26946 (-26.1%)
Home	0.3059	0.4089 (33.7%)	-	-	17783	23766 (33.6%)
No Government						
Agriculture	0.0043	0.0047 (8.4%)	0.0066	0.0084 (27.3%)	216	233 (7.9%)
Manuf.	0.0984	0.1176 (20.4%)	0.1517	0.2109 (39.0%)	4927	5890 (19.5%)
Service	0.5459	0.4355 (-20.1%)	0.8416	0.7808 (-7.2%)	27334	21809 (-20.2%)
Home	0.3514	0.4422 (25.9%)	-	-	17598	22142 (25.8%)