Measuring Long-Run Consumption

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Abstract

This paper documents a relationship between household demographics and substitution between home and market production and proposes it as an explanation of low frequency movements in consumption expenditures relative to GDP, in particular the secular increase in consumption's share in GDP since the 1980s. A growth model with an endogenously evolving allocation between home and market production is shown also to imply a drift in the share of market consumption to market output. Data from the Consumer Expenditure Survey and other sources confirm these effects in the cross-section and over the period from 1984-2004, and a quantitative exercise matches them up with demographic changes over the entire 20th century as documented in Census data. The implication is that periods in which hours of work per capita increase involve artificial increases in measured consumption, and an upward drift in the share of consumption expenditures in GDP. In addition, "true" consumption exhibits a closer link to long-term productivity trends,

1 Background

A large amount of economic activity takes place outside of formal markets, and thus goes unmeasured in official accounts. The extent of this non-market activity varies widely over space and time, as well as from one household to another. In less economically developed countries, or countries in which governments interfere heavily with the price system, more economic activity takes place within the home or in "informal" markets as compared to developed capitalist economies (e.g. Parente et al, 2000). Even within the latter, the division between market and non-market activity varies over the life-cycle (e.g. Aguiar and Hirst, 2005), by income level, and by household demographics (e.g. Greenwood et al, 2005).

Since Becker's (1976, 1981) pioneering work, economists have recognized that the same economic principles that apply to market activity can also be applied successfully to a range of non-market activities, especially those such as household production that are relatively close substitutes for market activity. Kuznets, in developing the National Income and Product Accounts (NIPAs) for the U.S. in the 1930s, made a conscious decision to measure only market activity, primarily because of availability of observable prices and quantities. This paper examines whether the omission of non-market labor and production can help explain two recent trends in U.S. data: The increase in consumption's share in income, and the increase in hours of work per capita, depicted in Figure 1. Both have increased somewhere on the order of 10 percent over the past two to three decades.

There has been considerable work on labor supply, particularly focused on the increased participation of women, in particular married women with children. The increase has been attributed variously to technology (Greenwood et al, 2005), "culture" (Fernandez, 2007), the development of birth control pills (Goldin and Katz, 2000), among other things. The increase in consumption's share of GDP has also received some attention. For example, Perri and Fogli (2006) connect it with the persistent current account deficit and the Great Moderation. They only purport to explain part of the increase in the current account deficit, and therefore only part of the upward drift in consumption's share of GDP, so the explanation proposed in this paper may be complementary to theirs. In addition, the upward drift in C/Y actually predates the downward drift of the current account.

Another relevant literature, mostly from the 1970s and 1980s,[1] seeks to develop alternatives to the National Income and Product Accounts (NIPAs) that can incorporate broader measures of economic activity, including non-market activity such as household production. Although this work is motivated by a widespread recognition that the standard methods result in flawed measures of economic activity (or of the contribution of economic activity to the general well-being), the alternatives have not succeeded in sup-

[1] See Eisner (1988) for an extensive survey.

planting the NIPAs. This failure probably stems from several factors: First, for the most part, since their inaccuracies are likely to be relatively stable, at least over short horizons, for many purposes, e.g. measuring quarterly or annual growth rates, the NIPAs do a reasonable job. Second, and related to the first, the advantages of relatively long historical series make it costly to revamp the accounts at any given time. Third, the alternatives often raise as many questions as they answer, so that one is left with the feeling that "the perfect is the enemy of the good."

Whatever the reason, there have been no systematically maintained alternative measures to compete with the official NIPAs. Nonetheless, there have been numerous efforts to measure non-market activity, and in particular the value of household production. Much of what is available suggests that non-market activity in the U.S. has grown more slowly than market activity, consistent with the idea that over time activity has shifted from non-market to market. A key hypothesis examined in this paper is that the shift from non-market to market consumption is not just a function of wealth or relative prices but also of household demographics, particularly the presence of adults who are not employed in the market. Of course these demographics are presumably themselves influenced by wealth and relative prices, but absent a complete story to endogenize these factors, we provisionally treat them as exogenous.

Finally, Aguiar and Hurst (2008) document a second source of potential mismeasurement of consumption stemming from expenditures on inputs into employment such as transportation and clothing. If the goal of measuring consumption expenditure is to get at the quantity that enters utility (or at least indirect utility), it would be preferable to omit such expenditures and treat them as work expenses. Note that these expenditures are more directly a function of employment and hours, as opposed to household structure

The bottom line is evidence that aggregate consumption growth over the last 40 years overstates true consumption growth, and that this mismeasurement contributes significantly to the widely noted increase of consumption's share in GDP. A rough correction also shows that consumption growth trends are more closely tied to productivity growth trends, as conventional theory would predict, whereas in the data they are more or less orthogonal. Finally, the paper also provides a theoretical framework in which market consumption and market labor move together at low frequencies, but in which true consumption and work hours are (relatively) stationary. The essential idea is that the demographic and labor market shifts described above result in shifts from home production to market production, disproportionately increasing market consumption expenditures, since market-produced capital is used for both home and market production. Data from the Consumer Expenditure Survey and other sources confirm these effects in the cross-section, and a quantitative exercise matches them up with demographic changes over time as documented in Census data.

2 Facts

2.1 Aggregate

As mentioned in the introduction, a striking fact (seen in Figure 1) about consumption's share of GDP and labor hours per capita is their comovement at low frequencies. Specifically, both have drifted upward from mid-1960s through the 1990s. Both also drifted down somewhat in the first twenty years of the sample, though less obviously for consumption. It is generally understood that the drift downward in labor hours per capita in the first two postwar decades is at least partly attributable to the changing age distribution of the population (e.g. Francis and Ramey, 2006). The upward drift in per capita hours since the early 1980s is largely attributable to increased labor force participation by women, in particular married women. There were also changes in male participation, as well as changes in the intensive margin among both males and females, as we shall see.

The drift in the consumption share and hours per capita break the low frequency link between consumption and productivity in the data, as seen in Figure 2. Of course the difference between the two reflects variation in hours per capita and the share of consumption in output. Letting C denote aggregate consumption, Y output, H hours, and N population, we have

$$C/N = (Y/H)\,(C/Y)\,(H/N)\,. \tag{1}$$

The demographic adjustments to C considered below will have the effect of both reducing the drift in C/Y and reducing the low-frequency comovement of C and H, thus making (adjusted) per capita consumption comove more closely at low frequencies with productivity (as standard neoclassical analysis that assumes stationary hours suggests it should).

The limited evidence from alternative national income accounting efforts provides some time series support for the view of a link between market work effort and the substitution of market for non-market consumption. For example, Eisner (1988) measures "unpaid household work" annually over the period 1948 to 1981. Over that period, combined market and non-market consumption expenditure grew roughly 0.5 percent more slowly than market consumption. Figure 3 shows the ratio of market to total consumption trending up. Per capita hours of work are not trending up over this time period, but are U-shaped, bottoming out in the early 1960s before drifting up. But some of the upward drift may reflect wealth effects, i.e. a non-homotheticity of preferences between market and non-market consumption goods.

To capture both effects, albeit informally, I run a logit regression with the (nominal) share of market consumption in total consumption as the dependent variable, with the hours per capita and lagged real

consumption as explanatory variables. The results are as follows:

$$\ln(PC_t/PX_t) - \ln(1 - PC_t/PX_t) = \underset{(0.102)}{1.770} + \underset{(0.011)}{0.371} \ln(H_t/N_t) + 0.192 \ln(C_{t-1})$$

Thus both effects are present and significant. While these results are just suggestive, they can be extrapolated to the post-1981 period. This is also shown in the Figure 3 as the dotted line beginning in 1982, along with a Hodrick-Prescott trend line.

As for employment and hours, while below we will examine more trends from micro data, we can learn something from the aggregate evidence. Figure 4 depicts the behavior of women's labor force participation, both as a whole and separately for married women. Much of the overall growth was due to the influx of married women, whose participation converged with that of non-married women. In fact, non-married women's participation was essentially flat between 1955 to 1975. Below we will examine evidence on changes in work effort on the intensive margin.

2.2 Evidence from micro data

It is well-known that certain kinds of expenditures have shifted toward market-produced goods and away from inputs to home production. One well-documented example of this is purchased meals as a share of total food expenditures, depicted in Figure 5a. Less than 15 percent in 1929, it had risen to more than 35 percent by the end of the 20th century. Presumably most of this increase is explained by the desire to substitute away from time-intensive home production as wages rise over time. But it also presumably means that the growth in total food expenditure exaggerates the growth in food consumption. And this is only one margin of substitution. As another example, Aguiar and Hirst (2007) document the substitution of shopping time for money (in the form of lower prices).

While we present an economic model below, the essential idea can be expressed as a matter of accounting. Let C denote "true" consumption, the sum of home production C_h and purchased goods (market consumption) C_m. At some level the distinction between C_m and C_h is arbitrary, as virtually all goods involve some combination of market goods and non-market input. Nonetheless in practice it is a reasonable distinction to make for a variety of consumption goods, e.g. meals cooked prepared at home vs. restaurant meals, child care provided by a non-employed parent vs. purchased at a day care center, housekeeping by a household member vs. a paid outsider. The presumption is that the official consumer expenditure data include only C_m.

To gauge the extent to which demographic factors influence choices of home versus market production, we

examine household spending data from the Consumer Expenditure Survey. The data cover the period 1984-2004. We consider two measures of expenditures on goods commonly produced at home but for which there are readily available substitution possibilities in market goods. One is again the ratio of expenditures on food away from to total food expenditures. The second is the ratio of expenditures on a range of such goods in addition to food, including household services such as gardening, lawn care, and laundry, as well as child care and care for elderly relatives, to total expenditures. As with food expenditures, the substitution into market versions of these goods may result in consumption expenditure growth overstating true consumption growth.

Using one observation (the first available) from each household in the survey over the period 1984-2004, we regress these expenditure ratios (multiplied by 100) on various demographic variables, notably those reflecting household composition and labor force participation. To get more accurate demographics, and over a longer period of time, we then fit the regressions to the same variables constructed from the decennial Census (from the Integrated Public Use Microdata Series, or IPUMS) covering the period 1910-2000. The main explanatory demographic variables are based three qualitative variables, each of which can take on three values. These are:

	Categories		
Description	0	1	2
Adults (A)	one	two married	two or more, non-married
Non-employment (N)	zero	one	two or more
Children (C)	zero	one	two or more

Since combinations involving $A = 0$ and $N = 2$ are not possible, this leaves twenty-four possible categories. Thus, a household with a married mother and father with three children, with one parent employed, would be in the $(1, 1, 2)$ bin. The key category from the point of view of understanding changes in home production over time is the N category, which gives a rough of view of the available time within a household for home production.

In the CEX, these categories are represented as follows (using household weights designed to make the

sample representative of the U.S. population in terms of age, race, and other demographic characteristics):

	$C = 0$			$C = 1$			$C = 2$		
Desc.	$N = 0$	$N = 1$	$N = 2$	$N = 0$	$N = 1$	$N = 2$	$N = 0$	$N = 1$	$N = 2$
$A = 0$	22.5	9.5	0	2.6	0.5	0	2.5	0.9	0
$A = 1$	9.8	4.8	4.9	5.2	1.8	0.1	8.6	3.9	0.2
$A = 2$	6.8	4.0	2.5	2.5	1.4	0.7	1.9	1.5	0.8

Thus, for example, summing across the rows shows that about 39 percent of the sample households are headed by a married couple, slightly fewer (38 percent) by a single adult. As might be expected, the "married" household percentage declined over the period (42.5 to 37.3) while the "single" percentage increased (36.0 to 38.4). Nearly 65 percent of the households had zero children, a number that showed little change over the 1984-2004 period.

Also included in the regressions where a 4th-order polynomial in the age of the respondent (generally the adult head of the household or spouse), and the log of real total expenditure (to allow for wealth effects). The latter, given that it is presumably measured with error, and especially because it is the denominator of one of the dependent variables, is instrumented using race and education measures. Table 1 displays the results. The column labeled "Food" is the percentage of total food expenditures on food away from home. The column labeled "Misc" is the share of miscellaneous household production-type expenses as described above (including meals) as a percentage of total expenditure. The "IV" columns report results when total expenditures are instrumented by race and household income. As one would expect, the percentages of expenditures on market goods are increasing in variables that reflect the value of time (employment, the levels of total expenditures) and decreasing in the variables that reflect available non-market time (the number of adult equivalents in the household, whether the household head is married). There is a gender effect—males are more likely to spend higher percentages on these goods—even after controlling for the other variables, probably in part proxying for left-out variables such as hours of employment.

Given the large increases in recent decades in demographic categories that predict higher expenditures on these home-production-type goods (two-career couples, single adult households) as well as increased wealth, it seems likely that such expenditures have increased in the aggregate data. There are two potentially offsetting effects, however. First, there is an increase in the proportion of retiree households, a group that is likely to substitute time for money by increasing household production (see Aguiar and Hurst, 2005, 2007), though as they age they would also likely purchase more services that they formerly provided for themselves. Second, Buera and Kaboski (2007) argue that some expenditures have shifted in the other

direction, especially in services such as transportation and laundry, where purchases of consumer durables result in increased home production.[2]

The next step is to translate these findings into implications for aggregate consumption patterns by tracking demographic changes in the population over time that correspond to the explanatory variables in Table 1. To get a more complete picture of demographic trends over a longer period of time, we measure the same set of qualitative household demographic variables in the IPUMS data decadally from 1910 to 2000. To give some idea of the extent of demographic change over the 20th century, Figure 6 shows the breakdown of households by the number of non-employed adults (zero, one, or more than one). Clearly the dramatic change in this figure is the increase in the fraction of households with zero non-employed adults, a trend that appears to have begun in the 1950s and petered out in the 1990s.

Using the regression results from the CEX and fitting them to the IPUMS data, we can get predicted values for the two expenditure shares (purchased meals as a fraction of total food expenditure, home-producibles as a share of total expenditures) over the 1910-2000 period. For food, we can gauge the validity of this exercise by comparing the results from this exercise with the food expenditure data from U.S. Historical statistics from 1929-1999. It turns out, as shown in Figure 5b, that the fitted values correspond remarkably well with the data.

The results for food expenditures suggest that this out-of-sample exercise is reasonable, and we can apply it more broadly to the home-producibles expenditure share. Figure 7 provides the fitted values for the out-of-sample exercise with regard to the expenditure share on home-producibles. Mirroring the patterns in Figures 5 and 6, the ratio is fairly flat through the 1950 census and then begins its relatively steep upward trajectory with 1960.

A second category of effects of increased labor force participation relevant for this exercise is work-related expenses. An individual who becomes employed will typically increase expenditures on goods such as transportation, clothing, and food away from home, as documented by Aguiar and Hurst (2008). While food expenditures have already been covered by the previous exercise, the other categories have not. Rather than reinvent the wheel, we can draw on Aguiar and Hurst's findings, notably that each employed spouse increases expenses on transportation, meals away from home, and clothing by about 300 bp (from a base of about 30 percent of total expenditures–i.e. from a share of 0.3 to 0.33 or 0.36). [The meals away from home is presumably already factored into the effects drawn from the CEX, as those included "purchased meals"—a broader category than meals away from home. On the other hand, expenditures on meals away from home presumably depends directly on labor force participation, not merely on non-employed adults.

[2] In addition, the effects of home to market substitution on aggregate consumption relative to GDP could also be affected by whether home production is more or less labor intensive than market production of the same good.

Thus, for example, a household with a single employed adult might spend as much on meals away from home as a household with one employed and one non-employed adult, if we think of meals away from home as largely meals purchased at or near one's place of employment.]

The final step of this empirical exercise is to gauge the impact of this on total consumption expenditures. We can illustrate this in part by the following grid with key demographic categories:

	zero non-empl	one non-empl	two non-empl
one adult households	$c_0\,(1 + a_1 + b_1 + d)$	$c_0\,(1 + d)$	$--$
two adult households	$c_0\,(1 + 2a_2 + b_2)$	$c_0\,(1 + a_2)$	c_0

Here a_i represents additional employment expenses and b_i represents the substitution of market expenditures for household production (which includes both wealth and substitution effects), d is the "single effect." Not included in this grid is a third dimension related to children: Having no children adds about 0.02 but reduces b_i. The CEX results suggest $a_1 \approx 0.15$, $a_2 \approx 0.10$, $b_1 \approx 0.03$, $b_2 \approx 0.02$, $d \approx 0.03$. The result of these calculations is an estimate of the joint impact of the substitution of market goods for home goods and the increase in employment-related expenses on aggregate consumption over time, displayed in Figure 8. Again the results indicate little change in the first half of the 20th century, but an increase in aggregate market consumption expenditures of about three percent in the second half.

The results show that this measurement issue can account for some of the upward drift in measured consumption expenditures over the past forty years, but appears at odds with the flat or declining C/Y and H/N during the 1947-65 period shown in Figure 1. In fact, aside from the consumption calculations what jumps out is the fact that as women's labor force participation increased dramatically in the 1950s, hours of work (both per capita and per worker) drifted downward. One likely explanation for the discrepancy is that the increases in female labor force participation in the 1950s may have been characterized by more part-time or low-wage employment, especially in comparison to the post-1970 era. If so, the changes at the extensive margin used to extrapolate out of sample would exaggerate the impact on consumption and hours of work relative to the post-1970 increases in participation. Evidence for this proposition can be pieced together from a number of sources. First, note that conditional on full-time, the female-to-male earnings ratio declines from the mid-1950s through the early 1970s (Figure 9), at which point it begins to steadily increase. This suggests that the new entrants to the labor force are in relatively low-earning positions. Second, a high portion of women working in the 1950s and 60s are either part-time or only employed part of the year (Figure 10). Following a brief dip during the Korean War, the share of working women in this category rises to nearly 50 percent by 1960 and remains close to that level until the mid-1970s. It then

declines steadily to about 35 percent by 1996.

The implication of these facts about women's labor market behavior in the 1950s and 1960s is that the entrants of married women into the labor force would likely have had a smaller impact on consumption patterns compared to the 1980s and 1990s, both because of smaller income effects and fewer hours of work. Notwithstanding the fact that the out-of-sample extrapolation of the meals away from home category matched up well with the data, it is likely that broader measures of consumption expenditures associated with either employment expenses or the substitution of market for home-produced goods were smaller in the first two postwar decades than suggested by Figure 8.

The next section describes a growth model in which technological progress results in the upward drift of the share of market consumption in total consumption expenditures. It shows, first, that normalizing consumption by hours of work can result in a closer approximation to true consumption; and, second, that the share of consumption in GDP also drifts up over time.

3 A Growth Model with Household Production

This section presents a general equilibrium growth model that is capable of generating time-varying market labor supply. There are two goods, a market good produced with market labor and capital, and a home good produced with household labor and capital. As the relative price of the two goods varies, the allocation of time between the two types of labor will vary. Since we measure only market labor and market consumption, using the latter as a measure of total consumption can be misleading. In particular, as the share of market consumption in total consumption increases, measured consumption will grow faster than "true" or total consumption.

We denote the number of hours per period the representative agent works by ℓ. The population is N_t at time t. We treat N_t as exogenous and growing exponentially at constant rate ν for the sake of characterizing balanced growth paths. Let C_h denote the aggregate non-market consumption ("household production") produced per unit of time, and C_m the aggregate market consumption good. We assume that C_m and homogeneous capital K are produced in the market sector m with capital K_m and labor ℓN_m, where N_m is the number of workers in sector m and ℓ is total hours of work per capita. Non-market consumption is produced in a second sector that also combines capital and labor. Labor in the h sector is assumed to be non-market. Production is Cobb-Douglass with Hicks-neutral progress denoted A_i $(i = m, h)$; the A_i are assumed to grow geometrically at rate γ_i. We will also assume (mainly for convenience) that capital's share α is the same in both sectors.

Let c_m and c_h denote per capita quantities of C_m and C_h, while k, and k_i refer to capital-worker ratios

(e.g. $k_h = K_h/N_h,\ k = K/N$; no subscript refers to aggregates), while $n_i = N_i/N$, $(i = m, h)$. We assume the representative agent's preferences are:

$$U = E\left\{\sum_{\tau=t}^{\infty}(1+\rho)^{t-\tau}\left[\ln(c_\tau) + b\ln(1-\ell_\tau)\right]\right\} \tag{2}$$

where $b > 0$ and $0 < \beta < 1$, and

$$c_t \equiv \left[\omega_m c_m^{(\epsilon-1)/\epsilon} + \omega_h c_h^{(\epsilon-1)/\epsilon}\right]^{\epsilon/(\epsilon-1)}. \tag{3}$$

The resource constraints are

$$\begin{aligned}
c_{mt} + (1+\nu)\,k_{t+1} - k_t(1-\delta) &= A_{mt}k_{mt}^{\alpha}\ell_t^{1-\alpha}n_{mt} && (4)\\
c_{ht} &= A_{ht}k_{ht}^{\alpha}\ell_t^{1-\alpha}n_{ht} && (5)\\
k_{mt}n_{mt} + k_{ht}n_{ht} &= k_t && (6)\\
n_{mt} + n_{ht} &= 1. && (7)
\end{aligned}$$

It is straightforward to show that $k_m = k_h$ is optimal, so we can simply use k and eliminate (6).

The first-order conditions for this problem are then (letting λ_{mt} and λ_{ht} denote the shadow prices of the constraints (4) and (5)):

$$\begin{aligned}
\omega_m c_t^{-(\epsilon-1)/\epsilon} c_{mt}^{-1/\epsilon} &= \lambda_{mt} && (8)\\
\omega_h c_t^{-(\epsilon-1)/\epsilon} c_{ht}^{-1/\epsilon} &= \lambda_{ht} && (9)\\
\theta/(1-\ell_t) &= \lambda_{mt}(1-\alpha)A_{mt}k_t^{\alpha}\ell_t^{-\alpha}n_{mt} && (10)\\
&\quad +\lambda_{ht}(1-\alpha)A_{ht}k_t^{\alpha}\ell_t^{-\alpha}n_{ht}\\
\lambda_{mt}A_{mt} &= \lambda_{ht}A_{ht} && (11)\\
\lambda_{mt}(1+\nu)(1+\rho) &= E_t\left\{\lambda_{mt+1}A_{mt+1}\alpha k_{t+1}^{\alpha-1}\ell_t^{1-\alpha} + 1 - \delta\right\} && (12)
\end{aligned}$$

These simplify further by letting $p_{ht} \equiv \lambda_{ht}/\lambda_{mt} = A_{mt}/A_{ht}$, and letting $x_t \equiv c_{mt} + p_{ht}c_{ht}$, with $\lambda_{mt} = x_t^{-1}$

(see Ngai-Pissarides, 2007):

$$\omega_m c_t^{-(\epsilon-1)/\epsilon} c_{mt}^{-1/\epsilon} x_t = 1 \tag{13}$$

$$\left(\frac{\omega_c}{\omega_h}\right)^{\epsilon} \frac{c_{ht}}{c_{mt}} = p_{ht}^{-\epsilon} \tag{14}$$

$$c_t \theta / (1-\ell_t) = (1-\alpha) A_{mt} k_t^{\alpha} \ell_t^{-\alpha} \tag{15}$$

$$(1+\nu)(1+\rho) = E_t \left\{ (x_t/x_{t+1}) A_{mt+1} \alpha k_{t+1}^{\alpha-1} \ell_t^{1-\alpha} + 1 - \delta \right\} \tag{16}$$

along with the usual transversality condition for k_t.

Alternatively, we can think of the specification (3) as permitting a two-step solution in which we solve for the path of c_t first, and then optimize over its allocation between c_m and c_h within each period. Since the relative price p_h of c_h in terms of c_m will be A_m/A_h, and both sectors will have the same capital-labor ratio k, we have

$$c_{mt} + p_{ht} c_{ht} + (1+\nu) k_{t+1} - k_t (1-\delta) = A_{mt} k_t^{\alpha} \ell_t^{1-\alpha} n_{mt} + p_{ht} A_{ht} k_t^{\alpha} \ell_t^{1-\alpha} n_{ht}$$

or, letting $P_t \equiv \left[\omega_c^{\epsilon} + \omega_h^{\epsilon} (A_{mt}/A_{ht})^{-(\epsilon-1)}\right]^{-1/(\epsilon-1)}$,

$$P_t c_t + (1+\nu) k_{t+1} - k_t (1-\delta) = A_{mt} k_t^{\alpha} \ell_t^{1-\alpha}, \tag{17}$$

since we know that $c_{mt} = \omega_c^{\epsilon} (1/P_t)^{-\epsilon} c_t$ and $c_{mt} = \omega_h^{\epsilon} (p_{ht}/P_t)^{-\epsilon} c_t$ imply that $P_t c_t = c_{mt} + p_{ht} c_{ht} = x_t$.

The first-order conditions for maximizing (2) subject to (17) are:

$$c_t^{-1} = \lambda_t P_t \tag{18}$$

$$b/(1-\ell_t) = \lambda_t (1-\alpha) A_{mt} k_t^{\alpha} \ell_t^{-\alpha} \tag{19}$$

$$\lambda_{t+1} \left[A_{m,t+1} \alpha k_{t+1}^{\alpha-1} \ell_{t+1}^{1-\alpha} + 1 - \delta\right] = \lambda_t (1+\nu)(1+\rho), \tag{20}$$

where λ_t is the shadow price on the resource constraint (17). The idea here will be that growth in A_m/A_h, coupled with $\epsilon > 1$, results in economic activity shifting over time from the household sector to the market sector. As we shall see, total economic activity behaves as in the standard growth model, but measured (i.e. market) activity does not.

3.1 Steady State and Balanced Growth

Aggregate output per worker y (in terms of the market good) is

$$y_t = A_{mt} k_t^{\alpha} \ell_t^{1-\alpha}. \tag{21}$$

We then have

$$(1+\nu)\, k_{t+1} = A_{mt} k_t^{\alpha} \ell_t^{1-\alpha} - x_t + k_t (1-\delta)$$

Also, we have from (18) that

$$\lambda'/\lambda = x/x' \tag{22}$$

so that

$$\begin{aligned} x'/x &= \left[A'_m \alpha k'^{\,\alpha-1} \ell^{1-\alpha} + 1 - \delta\right] \beta (1+\nu)^{-1} && (23) \\ k'/k &= \left[A_m k^{\alpha-1} \ell^{1-\alpha} - \left(\frac{x}{k}\right) + (1-\delta)\right] (1+\nu)^{-1}. && (24) \end{aligned}$$

We can define aggregate balanced growth as an equilibrium path in which x and k both grow at a the same constant rate, and the interest rate (i.e. the marginal product of capital) is also constant. Clearly we need $A_m \alpha k^{\alpha-1} \ell^{1-\alpha}$ to be constant, i.e.

$$k'/k = (1+\gamma_m)^{\frac{1}{1-\alpha}}. \tag{25}$$

Note that this is also the growth rate of output per worker, both in the aggregate (measured in units of sector m output) and in the m sector. It is also clear from (19) and (22) that this growth rate of k and x implies that ℓ is constant.

We can normalize the variables to characterize a "steady state." Let $\tilde{k} \equiv k A_m^{\frac{-1}{1-\alpha}} \ell^{-1}$, and similarly for $\tilde{y}$ and $\tilde{x}$. These variables will be constant along a balanced growth path. We can solve (24) and (**??**) for $\tilde{k}$ and $\tilde{x}$ after substituting for k and x. We get

$$\begin{aligned} \tilde{k}^* &= \left[\frac{\alpha}{(1+\nu)(1+g)(1+\rho) - (1-\delta)}\right]^{\frac{1}{1-\alpha}} \\ \tilde{x}^* &= \tilde{k}^{*\alpha} - \left[(1+\nu)(1+g) - (1-\delta)\right] \tilde{k}^* \end{aligned}$$

where $1+g \equiv (1+\gamma_m)^{\frac{1}{1-\alpha}}$. We also have

$$b/(1-\ell^*) = \tilde{x}^* (1-\alpha) \tilde{k}^{*\alpha} \tag{26}$$

determining ℓ along the balanced growth path.

In short, the aggregate economy behaves exactly as in the neoclassical growth model. If growth in A_m is stochastic, the aggregates will behave exactly as in the neoclassical model with stochastic growth. But the aggregates in this model do not correspond to measured GDP, consumption, and hours of work. The government only measures activity that occurs in markets. Household production is not included. To the extent there are trends or other changes in the shares of household versus market output, consumption, and labor, there will be (economically) spurious trends in the official series. In fact, the work of Aguiar and Hurst (2005) demonstrates that in microeconomic data there are such changes over the lifecycle that involve systematic comovements between market labor and market consumption—specifically that when people retire, they shift toward home production, so official measures of work hours and consumption expenditure both decline. We argue that something similar has happened in aggregate U.S. data over the past two to three decades, though in the opposite direction, as households have substituted market activity for household production.

Growth in A_m/A_h will generally affect relative prices and sectoral allocations of labor and capital, except in the special case of $\epsilon = 1$. Recall that

$$\begin{aligned} P_t &\equiv \left[\omega_m^\epsilon + \omega_h^\epsilon \left(A_{mt}/A_{ht}\right)^{-(\epsilon-1)}\right]^{-1/(\epsilon-1)} \\ c_{it} &= \omega_i^\epsilon \left(p_{it}/P_t\right)^{-\epsilon} c_t \qquad (i = m, h) \\ p_{ht} &= A_{mt}/A_{ht},\ p_{mt} \equiv 1 \end{aligned}$$

How does sectoral labor allocation evolve over time given some constant growth rate of A_h/A_m? Following Ngai-Pissarides (2004), let σ_h denote the expenditure share of c_h in x:.

$$\sigma_h \equiv \frac{p_h c_h}{c_m + p_h c_h} = \left(\frac{\omega_h}{\omega_m}\right)^\epsilon \left(\frac{A_m}{A_h}\right)^{1-\epsilon} \Big/ \left[1 + \left(\frac{\omega_h}{\omega_m}\right)^\epsilon \left(\frac{A_m}{A_h}\right)^{1-\epsilon}\right], \tag{27}$$

and $\sigma_m = 1 - \sigma_h$. Then $pc_h = A_m k^\alpha \ell^{1-\alpha} n_h = y n_h = \sigma_h x$, and we have

$$n_h = \sigma_h \frac{x}{y} \tag{28}$$

$$n_m = 1 - \frac{x}{y} + \sigma_m \frac{x}{y} \tag{29}$$

So although aggregate growth is balanced, $\epsilon > 1$ and $\gamma_m > \gamma_h$ implies that over time we have $\sigma_h \to 0,\ \sigma_m \to 1$. Consequently, in the long-run $n_m \to 1,\ n_h \to 0$. This may not be a realistic implication, but for reasonable parameters this transition occurs sufficiently slowly that the model can still be a good "local"

description of behavior over a very long time period.

Of course there are other theories about increased market labor. For example, regarding increased women's participation, which comprises much of the overall increase, Fernandez (2006) argues for the influence of "culture." But while the details will differ, the basic thrust of the argument—that a shift from household to market labor changes the relationship between observed consumption expenditure and "true" consumption—does not depend on the particular mechanism bringing about the change.

Figure 11 shows the results of a typical simulation of this model. The left panel shows total consumption expenditure versus measured market expenditure both raw and normalized by hours of work, demonstrating how the normalized series is closer total consumption. The right panel shows how measured consumption relative to GDP drifts up over time as a consequence of the shift toward market consumption.

The next section describes a more realistic model in which a representative two-adult household jointly decides the labor supply of each adult. Over time as wages grow the second adult shifts into the market sector and away from household production.

4 Family Labor Supply

Economists generally assume that the fundamental decision unit on the consumer side is the household, not the individual. Nowhere is this more important than in the labor market. Spouses may decide what to eat for lunch or what clothes to purchase more or less independently, but deciding whether or how much to work is almost surely best understood as the product of joint decisionmaking. And even if they decide selfishly, as long as there is any kind of merging of finances, income, or consumption their decisions will not be independent.

So now suppose there are $N/2$ identical households, each with two members. The total endowment of Preferences are the same as in (2) and (3), but now c_h and c_m represent total household quantities. The aggregate resource constraints $(4)-(7)$ also remain the same, but now there is additional detail to add from within the household. Let household members be designated by subscripts $j = 1$ or 2, and let $n_{js} \equiv N_{js}/N$ the population share that is type j in sector s. The only difference between types is that type 2 has effective labor in sector s of $\mu_s \leq 1$ per hour of actual labor . So we have

$$N_i = N_{1s} + \mu_s N_{2s} \quad s = m, h \tag{30}$$

or, dividing through by N:

$$n_s = n_{1s} + \mu_s n_{2s} \quad s = m, h. \tag{31}$$

Similarly, we also have

$$1/2 = n_{jm} + n_{jh} \quad j = 1, 2 \tag{32}$$

which is just the overall constraint on type j labor. Of course there are also non-negativity constraints on each of the four labor allocations.

The baseline assumption for the relative effective labor parameters will be $\mu_m < 1$, $\mu_h = 1$, and we can suppress the m subscript (i.e. $\mu_m \equiv \mu$). Since the absolute levels of these parameters is not meaningful, $\mu_h = 1$ is just a normalization. The parameter μ_m could represent differences in skill or anything else that results in a premium for type 1 workers in the m sector. While it is natural to think of the types as corresponding to male and female, the key is that matching is assumed to be non-assortive insofar as a household always consists of a type 1 and a type 2.[3]

The relevant resource constraints are now

$$c_{mt} + (1+\nu) k_{t+1} - k_t (1-\delta) = A_{mt} k_{mt}^{\alpha} \ell_t^{1-\alpha} (n_{1m} + \mu n_{2m}) \tag{33}$$

$$c_{ht} = A_{ht} k_{ht}^{\alpha} \ell_t^{1-\alpha} (n_{1h} + n_{2h}). \tag{34}$$

The first-order conditions are as follows (after allowing for the fact that at the optimum, $k_m = k_h$):

$$\omega_m c_t^{-(\epsilon-1)/\epsilon} c_{mt}^{-1/\epsilon} = \lambda_{mt} \tag{35}$$

$$\omega_h c_t^{-(\epsilon-1)/\epsilon} c_{ht}^{-1/\epsilon} = \lambda_{ht} \tag{36}$$

$$\theta / (1-\ell_t) = \lambda_{mt} (1-\alpha) A_{mt} k_t^{\alpha} \ell_t^{-\alpha} n_{mt} + \lambda_{ht} (1-\alpha) A_{ht} k_t^{\alpha} \ell_t^{-\alpha} n_{ht} \tag{37}$$

$$\lambda_m A_m - \lambda_h A_h \geq 0, \quad > \Rightarrow n_{1m} = 1/2 \tag{38}$$

$$\lambda_m A_m \mu - \lambda_h A_h \leq 0, \quad < \Rightarrow n_{2m} = 0. \tag{39}$$

$$\lambda_{mt} (1+\nu)(1+\rho) = \lambda_{mt+1} A_{mt+1} \alpha k_{t+1}^{\alpha-1} \ell_t^{1-\alpha} + 1 - \delta \tag{40}$$

Letting $p_{ht} \equiv \lambda_{ht}/\lambda_{mt} = A_{mt}/A_{ht}$, and letting $x_t \equiv c_{mt} + p_{ht} c_{ht}$, with $\lambda_{mt} = x_t^{-1}$ (see Ngai-Pissarides,

[3] Assortive matching would eliminate any interesting household dimension for the problem, as there would be just two types of households, one with high "productivity" and one with low. On the other hand, matching could be conditionally assortive if the model were extended to have distributions of skill levels for both types.

2007):

$$\omega_m c_t^{-(\epsilon-1)/\epsilon} c_{mt}^{-1/\epsilon} x_t = 1 \tag{41}$$

$$\left(\frac{\omega_c}{\omega_h}\right)^{\epsilon} \frac{c_{ht}}{c_{mt}} = p_{ht}^{-\epsilon} \tag{42}$$

$$x_t \theta / (1-\ell_t) = (1-\alpha) A_{mt} k_t^{\alpha} \ell_t^{-\alpha} (1+\mu^{\tau})/2 \tag{43}$$

$$(1+\nu)(1+\rho) = (x_t/x_{t+1}) A_{mt+1} \alpha k_{t+1}^{\alpha-1} \ell_t^{1-\alpha} + 1 - \delta \tag{44}$$

where $\tau = 0$ if $p_h = A_m/A_h$; $\tau = 1$ if $p_h = \mu A_m/A_h$. Otherwise $\tau \in (0,1)$ and is determined endogenously as described below.

The intuition is straightforward: Given that in equilibrium $k_m = k_h$, the allocations will depend on A_m/A_h, which by assumption is growing over time. Recall that the relative price of c_h is $p_h = \lambda_h/\lambda_m$. For some values of A_m/A_h, $p_h = A_m/A_h > \mu A_m/A_h$, in which case $n_{2m} = 0$. Once $n_{1m} = 1/2$, p_h begins to rise more slowly than A_m/A_h, reflecting the binding constraint on type 1 workers. Eventually $p_h = \mu A_m/A_h$ and it becomes worthwhile for type 2 workers to move into the m sector (technically they will be indifferent on the margin). In equilibrium this happens gradually as p_h resumes accelerating at rate $\gamma_m - \gamma_h$.[4]

It turns out that balanced growth only occurs in the "first" phase when $n_{1m} < 1/2$, and the "final" phase when $n_{2m} > 0$, but not during the intermediate phase when both types of workers are at corners. This is because the balanced growth paths differ, and the intermediate phase represents a transition between the two paths. To see this, note that

$$x_t + (1+\nu) k_{t+1} - k_t (1-\delta) = A_{mt} k_t^{\alpha} \ell_t^{1-\alpha} (1+\mu^{\tau})/2 \tag{45}$$

$$(1+\nu)(1+\rho) = (x_t/x_{t+1}) A_{mt+1} \alpha k_{t+1}^{\alpha-1} \ell_t^{1-\alpha} + 1 - \delta \tag{46}$$

$$x_t \theta / (1-\ell_t) = (1-\alpha) A_{mt} k_t^{\alpha} \ell_t^{-\alpha} (1+\mu^{\tau})/2 \tag{47}$$

We can divide x and k by $A_{mt}^{1/(1-\alpha)} \ell$ to get variables that are constant in the steady state. We then have (for $\tau = 0$ or $\tau = 1$)

$$\begin{aligned}
(1+\nu)(1+\rho)(1+g) &= \alpha \tilde{k}^{\alpha-1} + 1 - \delta \\
\tilde{x} &= \tilde{k}^{\alpha} (1+\mu^{\tau})/2 - [(1+\nu)(1+g) - (1-\delta)] \tilde{k} \\
\tilde{x} \ell \theta / (1-\ell) &= (1-\alpha) \tilde{k}^{\alpha} (1+\mu^{\tau})/2
\end{aligned}$$

[4] Of course all of this assumes that μ is constant over time. If μ increases toward 1, this would accelerate the movement of type 2 workers into the market labor force.

This in turn implies

$$\begin{aligned}
\tilde{k} &= \left[\frac{\alpha}{(1+\nu)(1+\rho)(1+g)-(1-\delta)}\right]^{1/(1-\alpha)} \\
\tilde{x} &= \tilde{k}^{\alpha}(1+\mu^{\tau})/2-[(1+\nu)(1+g)-(1-\delta)]\tilde{k} \\
\ell &= \frac{(1-\alpha)\tilde{k}^{\alpha}(1+\mu^{\tau})/2}{\theta\tilde{x}+(1-\alpha)\tilde{k}^{\alpha}(1+\mu^{\tau})/2}
\end{aligned}$$

If we compare $\tau = 0$ with $\tau = 1$, clearly $\tilde{x}$ gets smaller and ℓ gets larger, while $\tilde{k}$ is unaffected.

In the intermediate phase when $n_{1m} = 1/2$ and and $n_{2m} = 0$, p_h rises at a rate less than $\gamma_m - \gamma_h$. Output and consumption of the market good continue to increase, but only at rate γ_m, not augmented by shifts of labor into the market sector. Expenditure x_t declines as a share of towards its new long-run level.

In this intermediate phase, p_h is determined by the conditions

$$p_{ht} = \frac{\omega_h}{\omega_m}\left(\frac{c_{mt}}{c_{ht}}\right)^{1/\epsilon} \tag{48}$$

$$c_{mt}+(1+\nu)k_{t+1}-k_t(1-\delta) = 0.5A_{mt}k_t^{\alpha}\ell_t^{1-\alpha} \tag{49}$$

$$c_{ht} = 0.5A_{ht}k_t^{\alpha}\ell_t^{1-\alpha}. \tag{50}$$

Finally, when $n_{m2} > 0$, we have $p_h = \mu A_m/A_h$ from that point on. In these last two phases, aggregation implies that aggregate effective labor varies over time, shrinking slightly on a per capita basis as type 2 labor shifts from the household to the market sector.

5 Conclusions

This paper has provided evidence of substitution from home production to the purchase of market-produced goods, explained by a combination of income effects and demographic changes in the labor market in the second half of the twentieth century. Most significant of these changes is the reduction in the number of households with non-employed adults and with children. As a consequence, official consumption measures overstate the growth of consumption, and also will show upward drift in the share of consumption expenditures in GDP. Clearly more work needs to be done to calibrate the impact of changing labor market participation on consumption patterns in the early postwar period, when unfortunately more detailed data are somewhat harder to come by.

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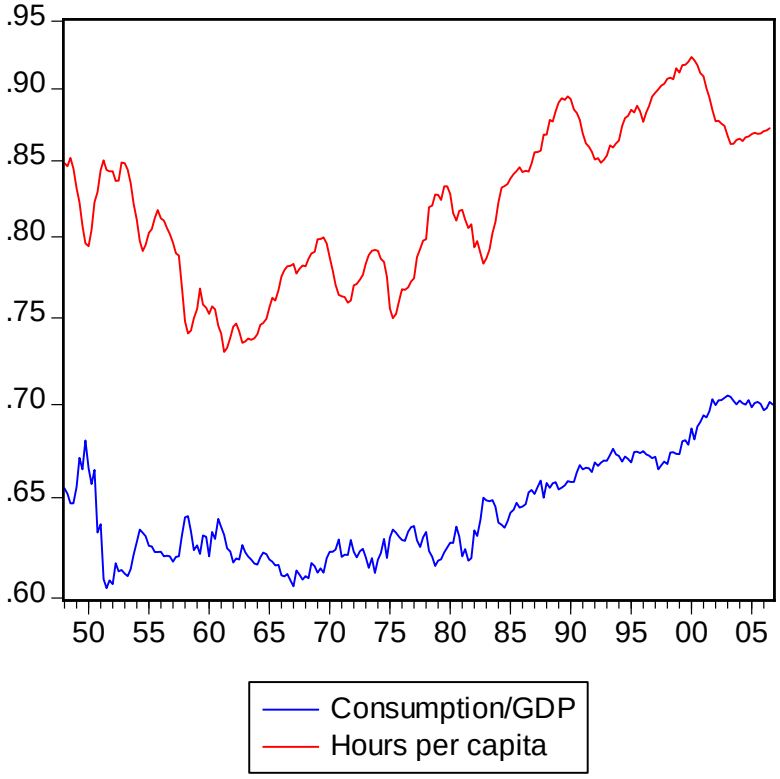
Table 1: Regression Results from the Consumer Expenditure Survey

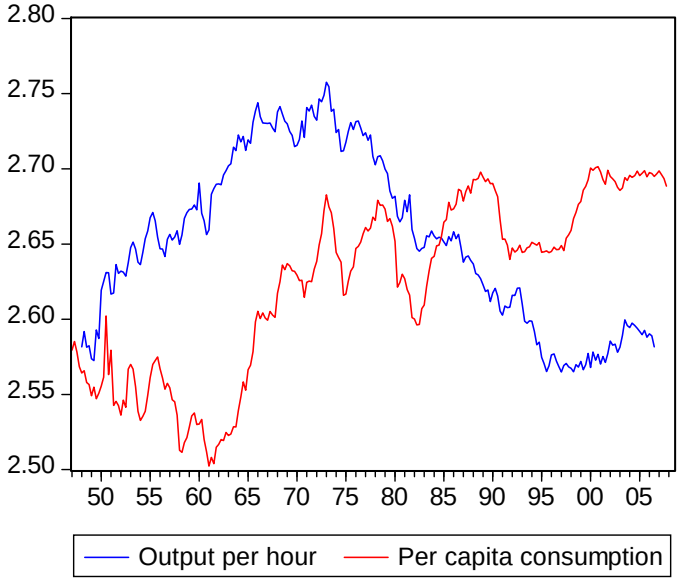
	Dep. Var			Overall	Food		Overall	Food
	Overall	Food	110	0.380	0.842	211	0.173	0.365
ANC				(0.033)	(0.038)		(0.039)	(0.043)
000	0.820	1.627	111	0.065	0.342	212	0.102	0.198
	(0.031)	(0.036)		(0.037)	(0.042)		(0.039)	(0.043)
001	0.624	0.871	112	0.042	0.168	220	0.256	0.522
	(0.035)	(0.040)		(0.034)	(0.038)		(0.036)	(0.040)
002	0.513	0.509	120	0.566	1.008	221	0.084	0.170
	(0.036)	(0.040)		(0.034)	(0.039)		(0.046)	(0.051)
010	0.849	1.481	121	0.205	0.495	age	-0.249	-0.438
	(0.034)	(0.038)		(0.085)	(0.098)		(0.013)	(0.014)
011	0.566	0.706	122	0.048	0.122	age^2	6.30E-03	1.19E-02
	(0.051)	(0.060)		(0.072)	(0.088)		(4.06E-04)	(4.53E-04)
012	0.358	0.214	200	0.315	0.810	age^3	-7.17E-05	-1.41E-04
	(0.044)	(0.051)		(0.033)	(0.037)		(5.43E-06)	(6.08E-06)
100	0.281	0.873	201	0.192	0.431	age^4	3.09E-07	6.18E-07
	(0.032)	(0.032)		(0.036)	(0.040)		(2.58E-08)	(2.92E-08)
101	0.264	0.480	202	0.160	0.283	ln(totexp)	0.568	0.946
	(0.033)	(0.038)		(0.037)	(0.041)		(0.013)	(0.015)
102	0.258	0.330	210	0.304	0.674	const.	-4.933	-4.553
	(0.033)	(0.037)		(0.034)	(0.038)		(0.149)	(0.166)

FIgure 1: Trends in Consumption/GDP and Hours of Work



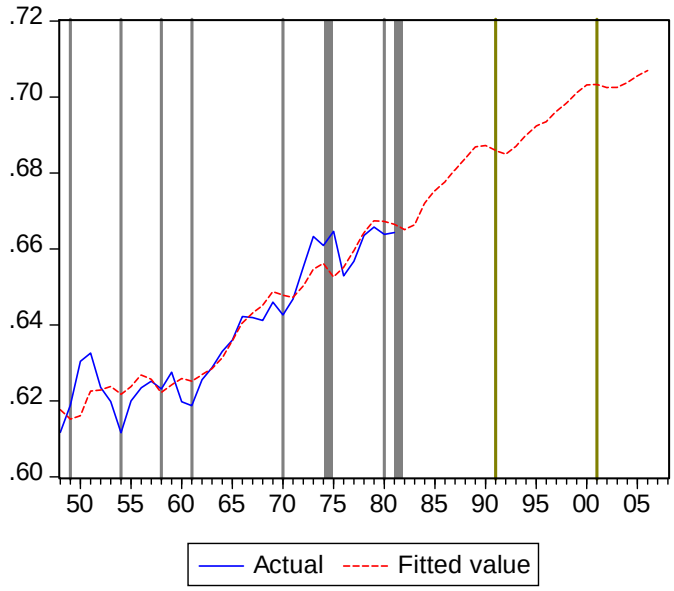
Note: log scale, hours of work in thousands

Figure 2: Productivity and Per Capita Consumption



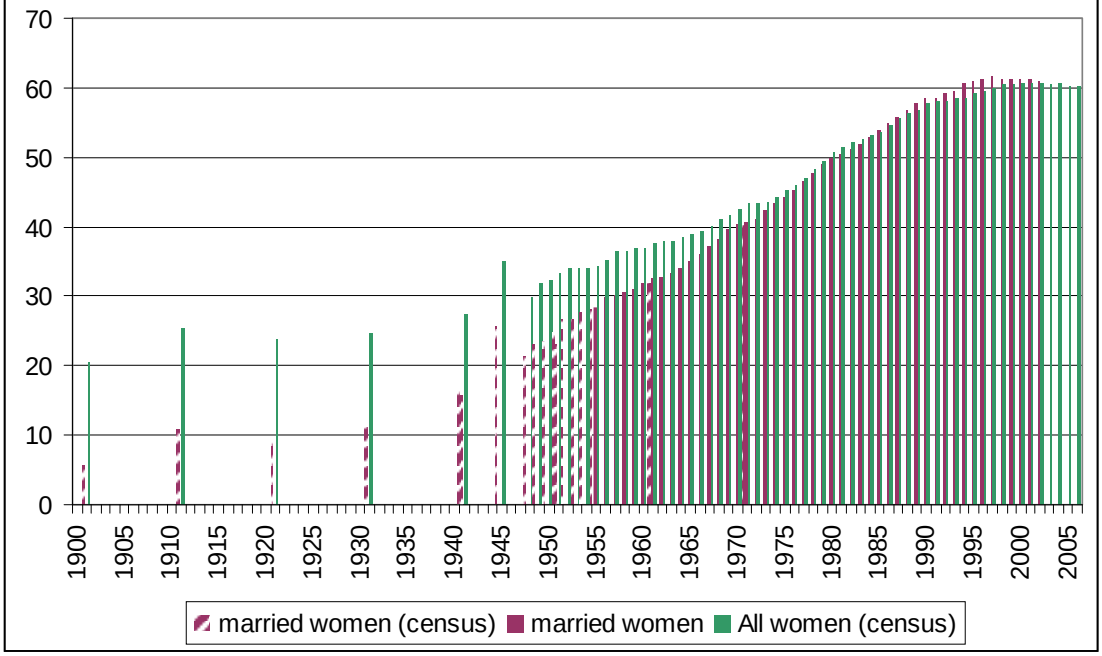
Note: Both series are in logs and have a common trend removed

Figure 3: Market Consumption Share of Total Consumption, 1948-81



Source: Eisner (1988), author's calculations

Figure 4: Women's Labor Force Participation, 1900-2005



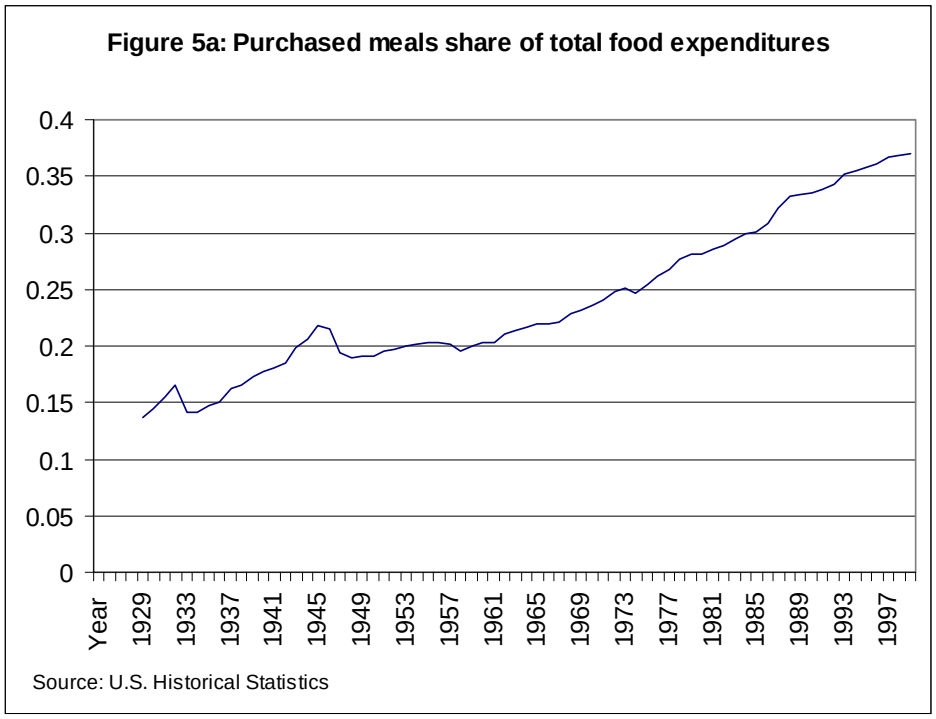


Figure 5a: Purchased meals share of total food expenditures
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Year
1929
1933
1937
1941
1945
1949
1953
1957
1961
1965
1969
1973
1977
1981
1985
1989
1993
1997
Source: U.S. Historical Statistics

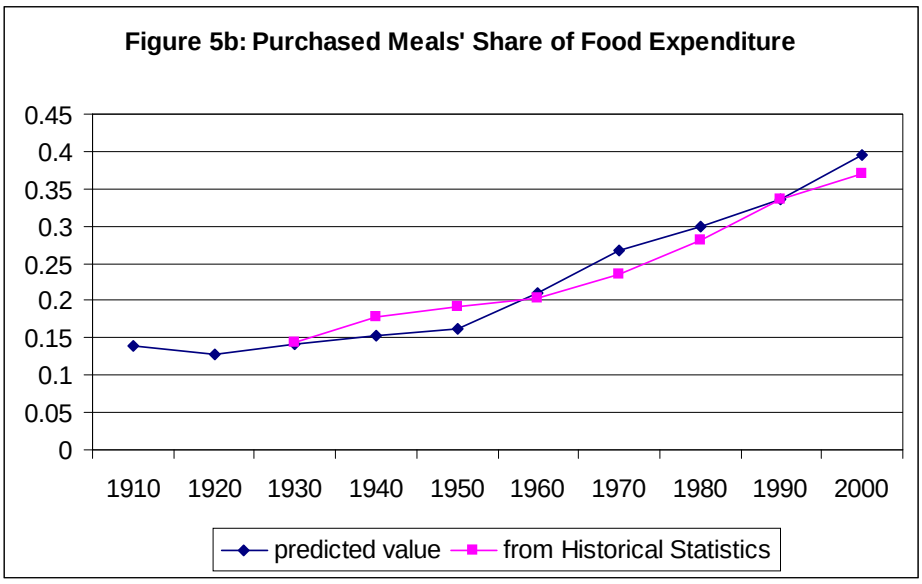


Figure 5b: Purchased Meals' Share of Food Expenditure
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
predicted value
from Historical Statistics

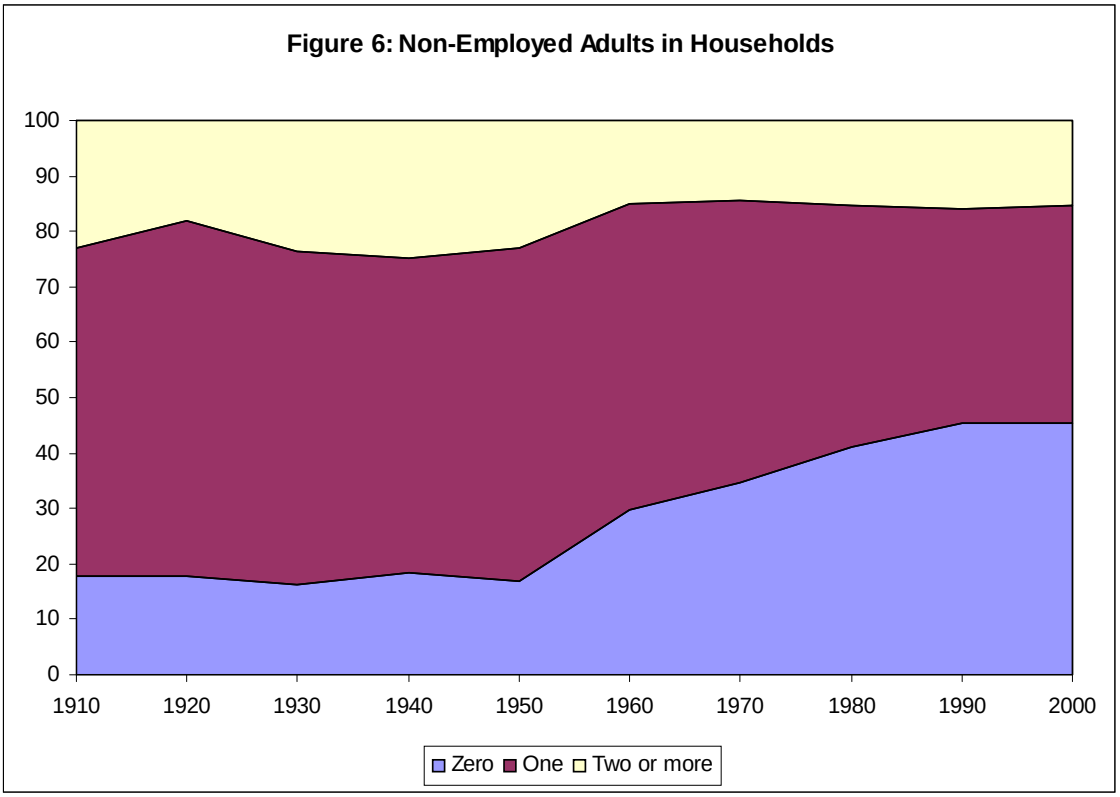


Figure 6: Non-Employed Adults in Households
100
90
80
70
60
50
40
30
20
10
0
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
Zero
One
Two or more

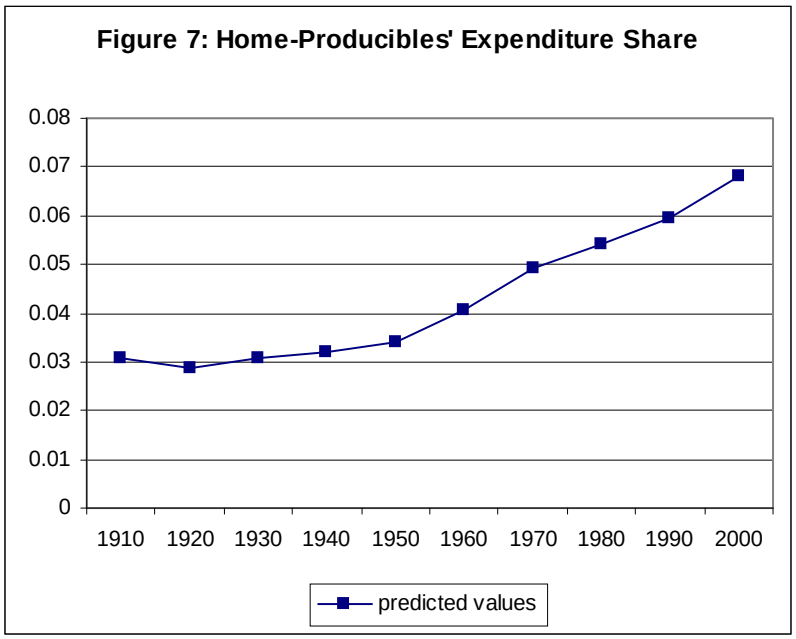


Figure 7: Home-Producibles' Expenditure Share
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
predicted values

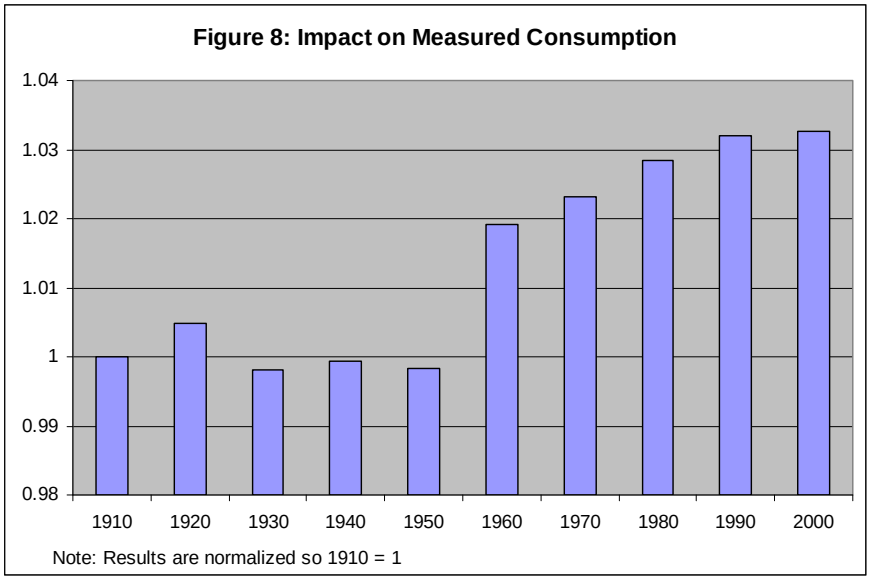


Figure 8: Impact on Measured Consumption
1.04
1.03
1.02
1.01
1
0.99
0.98
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
Note: Results are normalized so 1910 = 1

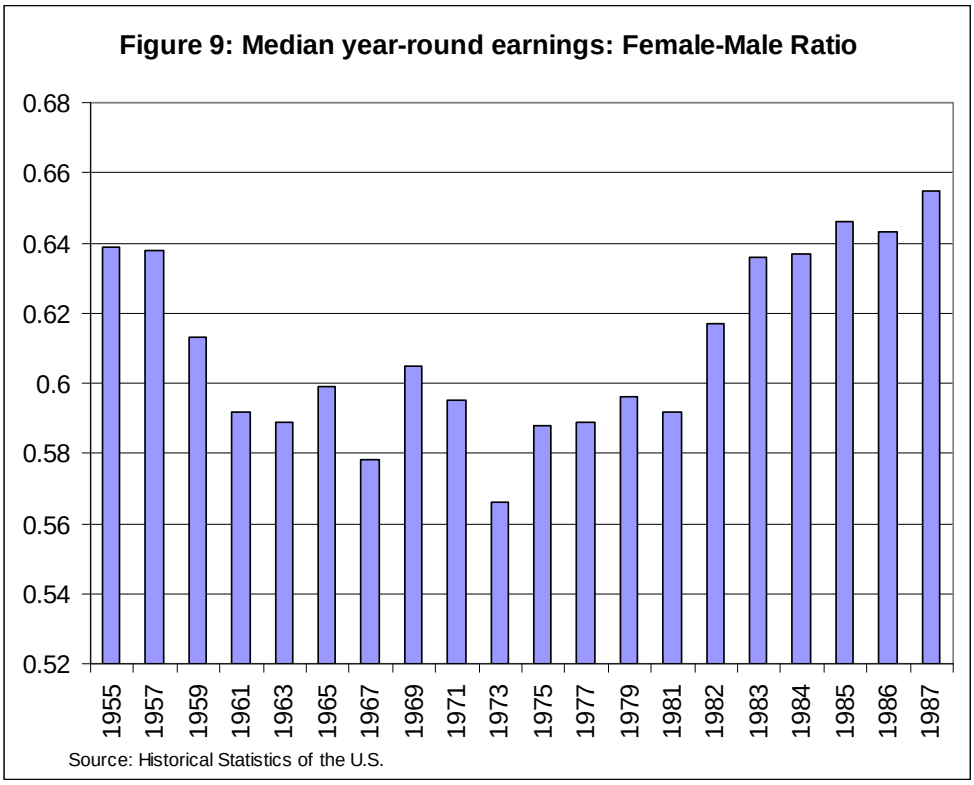


Figure 9: Median year-round earnings: Female-Male Ratio
0.68
0.66
0.64
0.62
0.6
0.58
0.56
0.54
0.52
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1982
1983
1984
1985
1986
1987
Source: Historical Statistics of the U.S.

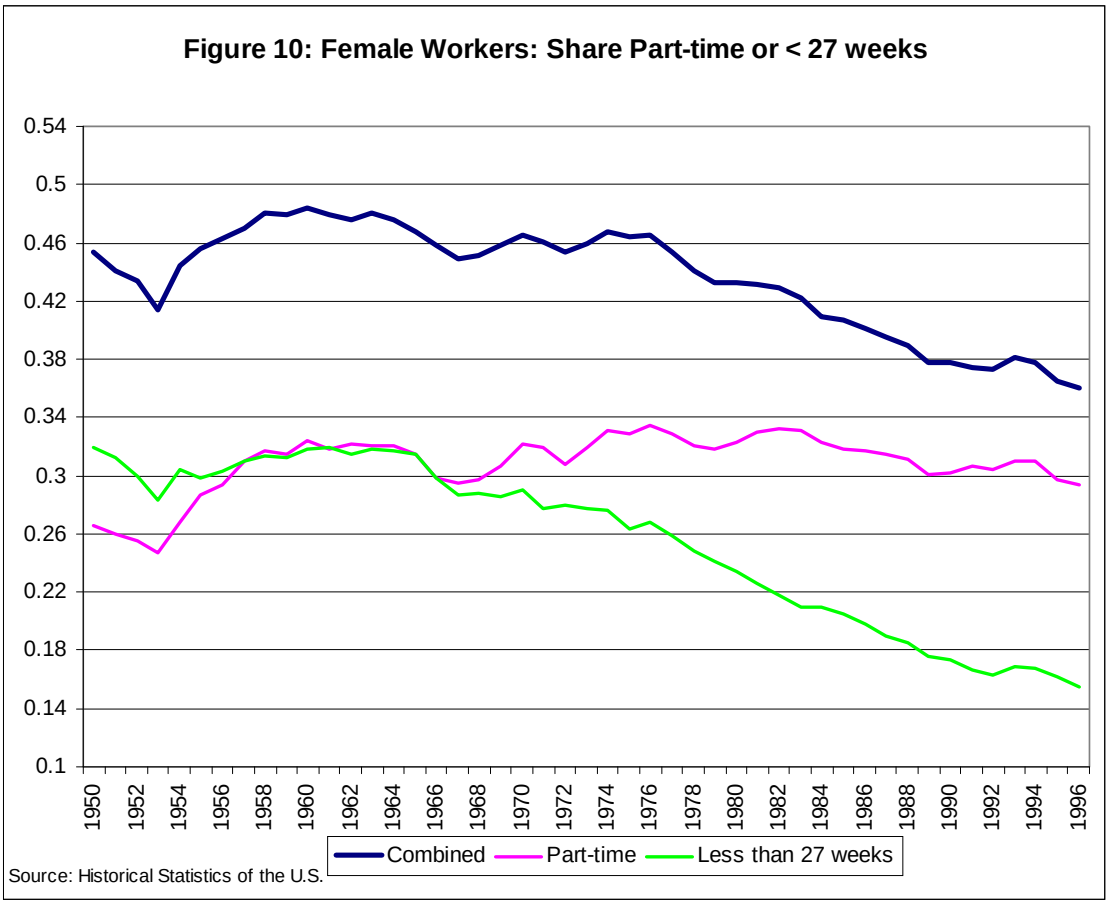
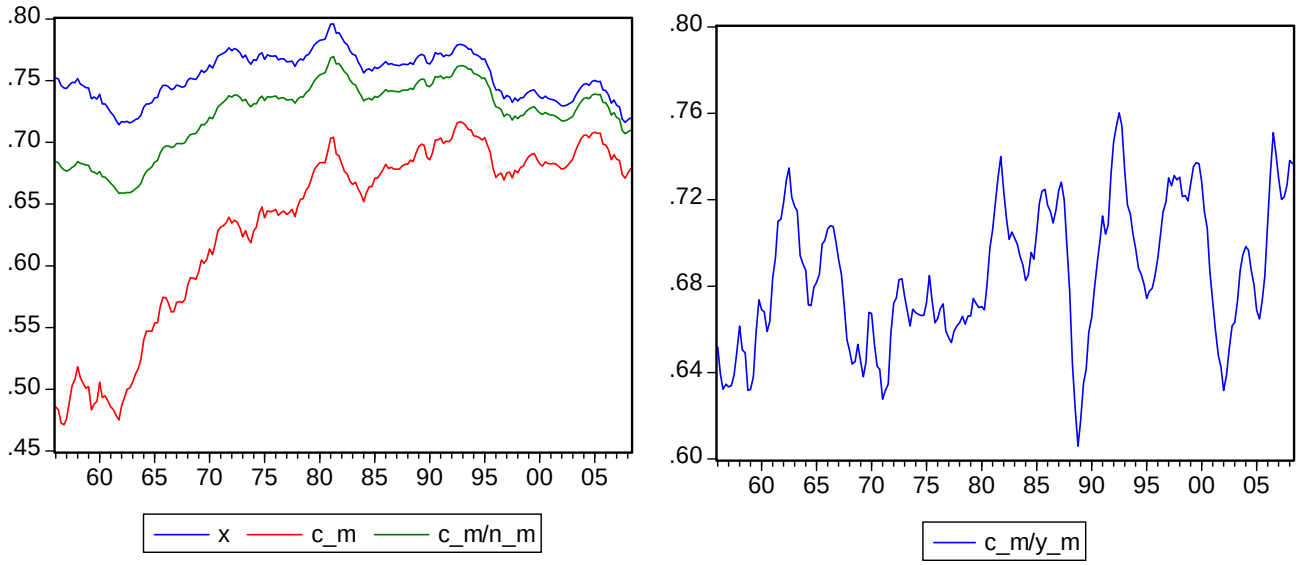



FIgure 11: Model Simulation