# The Macroeconomics of Obesity in the United States*

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**Abstract**

The weight of the average American adult male and female has increased by 16 and 14 pounds respectively and obesity rates have doubled since the early 1960s. Recent studies show these changes in weight can be attributed to the dramatic rise in the consumption of food away from home. We investigate the role of taxes and the gender wage gap in accounting for the trends in the composition of food consumed by the average American adult. According to our general equilibrium analysis, the observed movements in the personal income tax rate and in the gender wage gap explain the increase in the caloric intake from the consumption of food away from home. Our theory is also consistent with the patterns of time use on market activities, food preparation, and capital specific for cooking activities of Americans.

**JEL Classification:** E2, I1.
**Keywords:** Gender Wage Gap, Obesity.

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# 1 Introduction

It is widely known that obesity has increased all throughout the 20th Century. However, the steepness of the rate of obesity over the past forty years is what seems to be surprising. According to the National Health Examination and the National Health and Nutrition Examination surveys, the average weight of an adult American male has increased by 16 pounds since the early 1960s, from 166 to 182 pounds. Similarly, the average weight of an adult female has increased by 14 pounds, from 140 to 154.[1] Moreover, the highest increase in weight has been among married individuals, particularly among married women. Coincident with these trends, there has been a growing consensus about the health risks of obesity and physical inactivity, increasing the chances of suffering cancer, heart disease, and diabetes.[2]

This accelerating increase in obesity rates in the United States has been labeled as an "epidemic" by public health officials. In March 2004, the director of the Centers for Disease Control and Prevention, Julie Gerberding, predicted that obesity will overtake smoking as the leading cause of preventable deaths in the United States by next year if current trends continue.[3] Understanding the underlying forces explaining this rapid increase over the last 40 years is of paramount importance.

From an accounting point of view, people gain weight if calories consumed are greater than calories expended. A recent study by Cutler, Glaeser and Shapiro (2003) shows that increased caloric intake is far more important than reduced caloric expenditure in explaining recent increases in obesity [8]. The number of daily calories consumed by the average U.S. individual has increased by 236 during the last 25 years (from 1996 during 1971-74 to 2247 in 2000). Most importantly, almost all of the changes in calories consumed can be explained by the dramatic increase in the consumption of food away from home (USDA/ERS [15]). When eating out people either eat more, or eat higher-calorie foods- or both.

The objective of this paper is to examine the role of taxes and the gender wage gap in accounting for changes in the composition of food consumption, time use and increased caloric intake of American households. Decisions about what to eat depend on time allocation

[1] During the same time period the average height of a male and female adult has only increased one inch.

[2] See the National Heart, Lung, and Blood Institute, National Institutes of Health (2000) report for more on this issue.

[3] A person is considered obese when the percentage of body fat, according to age and gender, exceeds 5% of the average percentage for that age and gender classification.

and food choices. The value of time differs across individuals, as a result, these decisions are inherently economic. Thus even though when agents face the same price of the goods that are inputs into what to eat, they might choose different combinations of goods and time to generate the same amount of "eating" even when household incomes are equal, as suggested by Becker (1965) and Gronau (1977).

Our quantitative analysis is based on a dynamic general equilibrium model of the macroeconomy. This model includes the explicit distinction between men and women, either single or in a partnership. All representative agents care about food items (prepared at home or purchased away from home), non-food items and leisure. Eating at home demands cooking time, groceries and capital specific for cooking activities (like microwaves, etc.). Market goods require quality adjusted work to be produced. Agents in this economy are price takers and interact in markets for labor, capital, investment and market consumption. The main result from the general equilibrium analysis is that if there is some degree of substitution between cooking time and capital in the production of home meals, then the actual changes in the personal income tax rate and in the gender wage gap explains the increase in the caloric intake from the consumption of food away from home. Our theory is also consistent with the patterns of time use on market activities, food preparation, and capital specific for cooking activities of Americans.

To the best of our knowledge this is the first paper to examine the relation between taxes, the gender wage gap and the consumption of food eaten at home and food away from home in a general equilibrium framework. The transmission mechanism we evaluate is as follows: A decline in the personal income tax rate or corporate tax increases the after tax wage. Thus, it increases the opportunity cost of using time to cook food at home for both, men and women. Similarly, a decline in the relative gender wage gap only increases the average wage of women, and hence her cost of cooking food at home. Data shows that eating at home and eating away from home are close substitutes. Hence, a decline in either the personal income tax rate, the corporate tax or in the gender wage gap will increase the consumption of food away from home. Jones, Manuelli and McGrattan [13] have shown that the observed decline in the gender wage gap can fully account for the dramatic increase in hours worked of married women. The opportunity cost of time of married women has increased the most among the groups of individuals we consider and, as a matter of fact, they constitute the group that has gained the most weight over the last 40 years.

# 2 Literature Review

In the literature there have been several explanations for the increase in obesity in the United States over the past decades. Researchers have shown that obesity has a large genetic component, and this plays an important role in explaining why a given individual is obese. However, genetic characteristics in the population change very slowly, and so they clearly cannot explain why obesity in the U.S. has increased so rapidly in recent decades.[4] Researchers in the social sciences have instead sought to explain obesity by looking at technological developments, changes in taste and consumer habits, and the social environment.

Posner and Philipson (2003) use a partial-equilibrium model to study the hypothesis that changes in technology have lowered the cost of intake calories and raised the cost of expending calories, hence contributing in two ways to the rise in obesity. According to their hypothesis, technological change in food production has lowered the cost of producing calories, lowering its price. Technological change has also transformed the type of work people perform. In modern societies working requires far less physical activity than before. The increase in obesity may coincide with some of the changes pointed out by the authors; however, their study is only qualitative in nature. It is then difficult to conclude whether the economic forces pointed out by Posner and Philipson can account for the recent trends in obesity at a quantitative level.

Similarly, Lakdawalla and Philipson (2002) argue that declines in the real prices of grocery food items caused a surge in caloric intake that can, according to their regression analysis, account for as much as 40 percent of the increase in the body mass index (BMI) of adults since 1980.[5] Technological advances in agriculture caused grocery prices to fall and these declines caused consumers to demand more groceries.[6] According to the National and Income Accounts of the United States,[7] however, the average price of groceries (relative to the GDP

[4]See for example Chagnon, Rankinen, Snyder, Weisnagel, Perusse, and Bouchard (2003) for more on this issue.

[5]The body mass index or BMI is a measure of body fat based on height and weight that applies both to adult men and women. BMI is a routinely used indirect measure for body fatness, specifically obesity, in epidemiological research and is highly correlated with other direct measures like Dual-energy x-ray absorptiometry (DEXA) for older populations.

[6]Within this spirit, Burke and Heiland (2005) consider how a decrease in prices of certain foods may affect the social norms regarding obesity.

[7]See the background data section for the exact numbers and data sources.

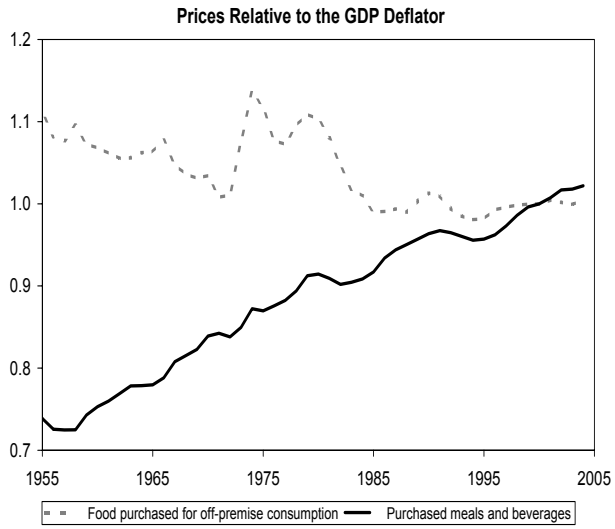


Figure 1: Price of groceries and food away from home relative to the GDP deflator.

deflator) during 1995-2004 is very similar to the corresponding 1955-1965 average. Moreover, during 1973-74 the price of groceries increased and stayed at high levels until 1979. Increased food prices were not followed by a decline in average weight, as any hypothesis based on the level of the relative price of food would conclude. From 1979 to 1985 grocery prices declined. Food prices have been stable since 1985 at a level comparable to the period 1960-72. Hence, the only time when increased weight in the adult population can be potentially attributed to lower food prices is for the period 1979-85, see Figure 1. Unfortunately for this hypothesis, most of the observed increase in weight has occurred over a period longer than 6 years. Even more important than the aforementioned trends in grocery prices is the fact that most of the increase in weight can be attributed to higher consumption of food away from home and not to higher consumption of groceries. When one considers the price of food away from home relative to both the CPI and GDP deflator one finds that these prices increased, in a smooth fashion during 1955-2004. In spite of this, the consumption of food away from home has increased almost continuously all over the 1955-2004 period. In summary, it seems that the behavior of food prices will have a hard time accounting the recent obesity trends in the United States.

Important technological changes in the home seem to have fostered more caloric intake, too. Cutler, Glaeser, and Shapiro (2003), present evidence suggesting that the tools responsible for reductions in the time we spend preparing meals at home have contributed to an increase in caloric consumption. Microwaveable meals and other foods that are easy to cook and quicker to prepare, making them more desirable when households face high opportunity costs of their time. In this paper we also explore the role of kitchen capital. Our model highlights that even if there is a steady decrease in the price of capital it does not necessarily affect cooking times nor the consumption of food away from home. Thus the resulting effects of this price decrease on the observables of the model are not quantitatively relevant for the period considered.

Finally, there is a growing body of empirical studies which emphasize the role of the change in the composition of food Americans consume as one of the main factors behind the weight status of the population. Young and Nestle (2002) suggest that increased portion sizes are one of the key elements in explaining the increased obesity epidemics in the United States. In their study they sample foods sold for immediate consumption in the most popular take-out establishments, fast-food outlets, and family-type restaurants. The data indicate that the sizes of current marketplace foods almost universally exceed the sizes of those offered in the 1970s.[8] Moreover, Lin, Guthrie and Frazao (2002) have shown that food away from home are higher in fat and saturated fat, and lower in fiber and calcium than foods cooked at home. Similarly, Prentice and Jebb (2003) find that the highest correlation between calories consumed per unit volume (energy density) and fat content is found in fast foods closely followed by prepared meals. Moreover, they find that people spontaneously ingest more energy on high energy density (high fat) than low energy density diets –a phenomenon known as "high fat hyperphagia". These studies then suggest that it does not take a disproportionate amount of food to ingest more calories when eating away from home. In our model we incorporate the findings of these studies and try to determine how much of the increase in the weight of Americans over the last 40 years is due to the shift in the consumption patterns of households.

[8]When foods such as beer and chocolate bars were introduced, they generally appeared in just 1 size, which was smaller than or equal to the smallest size currently available. This observation also holds for french fries, hamburgers, and soda, for which current sizes are 2 to 5 times larger than the originals.

# 3 Background Data

In this section we document facts about (i) time use (including labor supply and cooking and clean up times), (ii) food expenditures and calories by gender and type of food that we consider in this study, (iii) the gender wage gap, marginal income tax rates on labor and capital incomes, by gender and marital status, as well as the tax rate on corporate output, and (iv) technological change in the food producing sectors and in the capital goods employed to cook food at home.

Changes in the levels and composition of hours allocated to market and home production by gender and marital status since the 1960s are notable. Table 1A reports a summary of the hours worked by marital status and gender. Similarly, Table 1B reports the time devoted to food preparation and clean up also by gender and marital status; see the Appendix for more details.

| **Households** | **1960** | **1990** |
|---|---|---|
| **Married couples** | | |
| Hours worked (female) | 10.65 | 22.22 |
| Hours worked (male) | 39.4 | 38.86 |
| **Single females** | | |
| Hours worked | 22.37 | 24.7 |
| **Single males** | | |
| Hours worked | 27.87 | 27.82 |

Table 1a: Average number of weekly working hours by Gender and Marital Status.

The most striking features from Table 1A are that the average number of hours worked by married women has more than doubled with an increase of 108%. Similarly, single women work more now than during the 1960s with an increase of 10%. On the other hand, single men work basically the same number of hours in the two periods considered, while married males work a bit less with a 1% decrease in their working hours.

| **Households** | **1965** | **1995** |
|---|---|---|
| **Married couples** | | |
| Hours food prep. (female) | 12.98 | 6.43 |
| Hours food prep. (male) | 1.24 | 1.68 |
| **Single females** | | |
| Hours food prep. | 7.0 | 3.8 |
| **Single males** | | |
| Hours food prep. | 2.1 | 2.08 |

Table 1b: Average number of weekly hours devoted to food preparation and clean up by Gender and Marital Status.

With respect to time spent in food preparation and clean up, Table 1B reveals that the average number of hours that married women devote to these activities has decreased by 50%. Similarly, single women spent 45% less time preparing home food and cleaning up in 1995 than in 1965. On the other hand, married men devote 35% more time to home food preparation and clean up while single males devote basically the same time to it.

The data reported on Tables 1A and 1B play an important role in our analysis. The 1960s data is used to calibrate some of the parameters of the model. Moreover, Tables 1A and 1B are also used to confront the 1990s time-use predictions from the model to the observations of the U.S. economy.

With respect to the different consumption patterns among the different food choices considered in this paper, Table 2A reports the per capita annual expenditures relative to the GDP deflator of the different types of food for the two periods considered in the model; see the Appendix for more details.

| **Aggregate economy** | **% Change** |
|---|---|
| Exp. Groceries | -46% |
| Exp. Food Away from Home | 40% |

TABLE 2A: PER CAPITA REAL ANNUAL EXPENDITURES FOR THE DIFFERENT TYPES OF FOOD RELATIVE TO A 2% TREND.

As we can see from Table 2A, the relative real per capita expenditures on groceries has decreased by 46%. On the other hand, expenditures on food away from home have increased by 40%. Given the observed prices and the per capita annual expenditures we can infer a significant shift in the consumption patterns of American households over the last 40 years. Table 2B reports the resulting per capita daily calories of the different types of foods by gender for the periods considered in this model.

| **Aggregate economy** | **1965** | **1995** | **% Change** |
|---|---|---|---|
| Total calories | 1996 | 2232 | 12% |
| From Groceries | 1557 | 1496 | -4% |
| From Food Away from Home | 439 | 736 | 67% |
| For Males | 2450 | 2666 | 9% |
| For Females | 1542 | 1798 | 18% |

TABLE 2B: PER CAPITA TOTAL DAILY CALORIES OF DIFFERENT TYPES OF FOODS AND BY GENDER.

As we can see from Table 2B, the increase in calories are mainly driven by the increase of calories consumed from food eaten away from home. Moreover, the group of the population

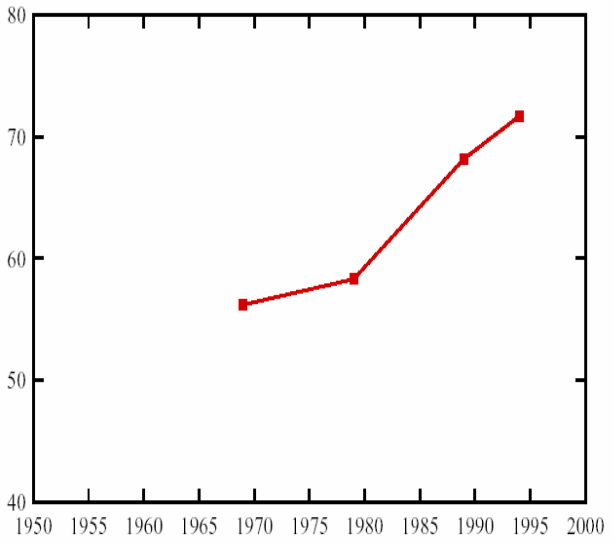


Figure 2: Average earnings of females Relative to males

that has seen a larger increase in the the number of calories consumed have been females which is also the group that has experienced the highest increase in its opportunity cost of time.

The size and nature of the "gender wage gap" has been well-documented, Goldin [11]. Women working full-time earned on average 54% of what men earned in the 1960's. This ratio remained relatively flat until the late 1970s and then rose to about 74% by 1997. The "gender wage gap" is difficult to interpret as it can either measure the direct effects of discrimination or differences in unmeasured skills correlated with gender. To keep our analysis simple we take the data on the "gender wage gap" as given and introduce it into our model as a gender-specific tax. Similar results can be obtained in a model with endogenous skill differences by gender or glass ceilings, Jones et. al. [13].

One of the key mechanism driving the shift in consumption and the increased obesity rates of all households in our model is due to the increased opportunity cost of cooking at home. Changes in taxes by gender and marital status are going to be important and will be directly incorporated into the model as reported in Table 3; see Appendix for more details.

| **Taxes** | **1955-65** | **1995-04** |
|---|---|---|
| **Households** | | |
| Married couples | 22% | 15% |
| Single females | 22% | 15% |
| Single males | 22% | 22% |
| **Corporate output** | 10% | 8% |
| Capital income | 23% | 16% |

Table 3: Marginal Corporate and Personal Income Tax rates by Gender and Marital Status.

The tax reform of the mid 1980s translated into a lowering of the personal income tax rate. In the case of single men, however, the reduction in the tax rate did not change as much as other households in the 1990s. On the other hand, single women and married households have seen their average tax rates been reduced the most. Finally, corporations have seen their corporate taxes decrease, which in our model results in higher equilibrium wages. All of these changes are going to have important implications on the opportunity cost of cooking at home for the different households.

In order to detect changes in the speed of technological advances in the food production sector we follow the approach of Greenwood, Hercowitz and Krusell [9]. Whenever a certain sector in the economy experiences a rate of technical advance faster than that of total factor productivity in the economy then the price of the output of that sector will tend to decrease relative to the GDP deflator. Following this procedure, we find that there has been extremely fast growth in the production of capital specific for home cooking activities (kitchen and other household appliances in the U.S. NIPA). The price of this type of investment good has declined by more than 5-fold over the last 40 years. It is important to emphasize, however, that the rate of decline in the relative price of cooking capital has been basically constant during our whole sample period, see Figure 2.[9] Regarding the production of groceries (food purchased for off-premise consumption), the detailed tables of personal consumption expenditures show that its 1955-65 average relative price is basically equal to its 1995-2004 one.

Given these facts we are now going to present a model for the different types of households where agents face different labor and consumption choices so that we can determine the total number of calories resulting from their food choices.

[9]This feature of the data is important since allow us to compare two different balance growth paths with the same price growth rates.

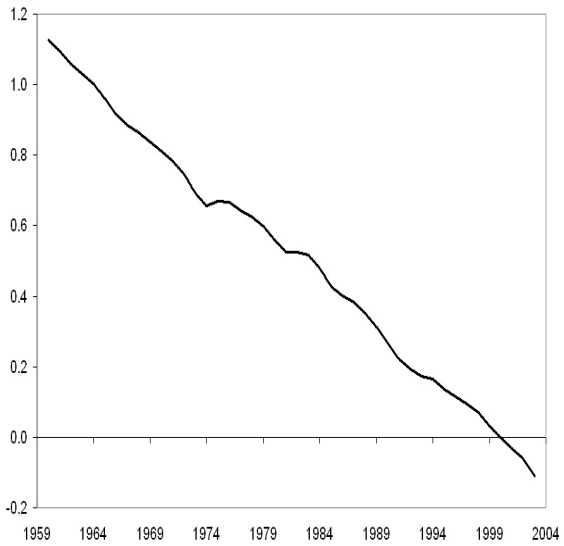


Figure 3: Logarithm of the Relative price of kitchen and other household appliances.

# 4 The Model

In this section we lay out the different type of households and activities that they perform in this economy. Our model is an extension to that of Jones et. al. [13] where we incorporate food preparation and consumption decisions. We consider a setting in which representative households –single women, single men, and married couples– must decide how to allocate their labor endowments across market activities and the production of food at home. Households must also decide how much to spend on groceries for cooking food at home, on meals outside the home and on other non-food items. Households invest in capital goods used in cooking and in market activities. Home food production requires the use of both labor inputs and capital goods. All households face a common set of technological restrictions, and each is taxed on the income earned in the market sector. We model the gender wage gap as tax wedges which differ by gender.

***Married Households***

We present now the problem of a representative married couple, or partnership. We assume that the bargaining problem within the household is resolved efficiently, so that a weighted form of a planner's problem describes the decisions that the couple makes. The preferences of such a partnership over consumption and leisure streams can be represented

by the following expression:

$$\sum_t \beta^t (1+n)^t \{\lambda_f \left( \alpha\, ln(C^{pf}_{F,t}) + \nu\, ln(C^{pf}_{NF,t}) + (1-\alpha-\nu)\, \frac{\left(\hat{L} - L^{pf}_{h,t} - L^{pf}_{m,t}\right)^{1-\sigma}}{1-\sigma} \right) + \quad (1)$$

$$(1-\lambda_f) \left( \alpha\, ln(C^{pm}_{F,t}) + \nu\, ln(C^{pm}_{NF,t}) + (1-\alpha-\nu)\, \frac{\left(\hat{L} - L^{pm}_{h,t} - L^{pm}_{m,t}\right)^{1-\sigma}}{1-\sigma} \right) \};$$

where the first superscript $p$ indicates partnership and the second indicates the type within the household; i.e., $f$ $(m)$ for female (male); the subscripts $m$, $h$ stand for market and household activities respectively and the subscript $t$ represents time. Agents in this economy have an endowment of $\hat{L}$ hours.[10] The relative weight of the woman in a partnership is $\lambda_f$, $\beta$ is the discount factor, $n$ denotes the population growth rate and $\sigma$, $\alpha$ and $\nu$ are preference parameters.

The problem of the partnership is to maximize equation (1) subject to several constraints. First, total food consumption in the married household, $C^p_F$, can be obtained through foods eaten away from home $(F^p)$ and home meals $(HF^p)$; which is given by:

$$C^p_{F,t} = C^{pf}_{F,t} + C^{pm}_{F,t} = \left(\mu_1 \left(F^p_t\right)^\gamma + (1-\mu_1)\left(HF^p_t\right)^\gamma\right)^{1/\gamma}; \quad (2)$$

where $\gamma$ denotes the degree of substitution between foods eaten away from home and home meals, and $\mu_1$ represents the relative importance of food away from home. Home meals are produced using capital specific for cooking activities, $k^p_h$, together with groceries, $I^p$, and female and male cooking labor $(L^{pf}_h, L^{pm}_h)$.

$$HF^p = \left( \zeta_2 (k^p_h)^{\zeta_3} + (1-\zeta_2) \left( \left( min \left[ I^p, \zeta_0 \left( \zeta_1 L^{pf}_h)^\rho + (1-\zeta_1)(L^{pm}_h)^\rho \right)^{1/\rho} \right] \right)^{\zeta_3} \right) \right)^{1/\zeta_3}; \quad (3)$$

where $\zeta_3$ is the elasticity of substitution between cooking capital and the composite ingredients-cooking time. $\zeta_2$ is the relative importance of cooking capital, $\rho$ denotes the degree of substitution between female and male cooking hours, $\zeta_1$ is the relative importance of female cooking hours and $\zeta_0$ is a conversion factor between groceries and labor cooking hours.

Households enjoy consumption goods other than food, $NF$. These goods are acquired in the market and total food consumption of non food items are given by:

$$C^p_{NF,t} = C^{pf}_{NF,t} + C^{pm}_{NF,t} = NF^p_t. \quad (4)$$

[10] Time-use studies show that Americans sleep 8 hours per day [8]. During the average day, 1 hour of time is used for eating and 1 hour for obtaining goods and services. Therefore, we assume each individual has 14 hours available per day, or $\hat{L}$=5488 hours per year.

Households can also invest in the capital stock used in market activities as well as in capital specific for cooking activities. These capitals evolve over time according to:

$$k^p_{m,t+1} = X^p_{m,t} + (1-\delta)k^p_{m,t} \tag{5}$$

$$k^p_{h,t+1} = q_{h,t}X^p_{h,t} + (1-\delta)k^p_{h,t}; \tag{6}$$

where $X$ represents investment, $\delta$ denotes the depreciation rate. We model technological advances in the production of investment goods as in Greenwood et. al. [9] so that $1/q$ is the relative price of an investment good. Finally, households face the typical budget constraint given by:

$$P_{F,t}F^p_t + P_{NF,t}NF^p_t + P_{I,t}I^p_t + X^p_{m,t} + X^p_{h,t} + R_t b^p_t \leq \tag{7}$$

$$(1-\tau^p)\left(w_t((1-\tau_d)L^{pf}_{m,t} + L^{pm}_{m,t})\right) + (1-\tau_k)(r_{t+1}-\delta)k^p_{m,t} + \delta k^p_{m,t} + b^p_{t+1} + T^p_t$$

where $L^{p,j}_m$ denotes hours devoted to market activities by the members in the partnership for $j$=$f, m$, $b^p$ are bond holdings, $\tau^p$ denotes the tax on labor income, $\tau_k$ denotes the tax on capital income, $\tau_d$ denotes the gender wage gap tax, $P_j$ corresponds to the price of good $j$ relative to the GDP deflator, where $j = F, N, I, F_H$; $w$ is the wage rate, $r$ corresponds to the rental rate on capital, $R$ is the return on bonds and, finally $T^p$ are taxes rebated to households as lump sum transfers.

This economy is also populated by representative single male and female households whose preferences and optimization problems are analogous to the partnership's problem.

***Technological Constraints and Aggregate Feasibility***

Our economy also has a representative competitive firm, which maximizes after tax profits

$$\pi = (1-\tau_c)K^\theta_m(AL_m)^{1-\theta} - wL_m - rK_m$$

where $K_m$ and $L_m$ denote total capital and labor inputs available in the market sector given the prevailing prices. $A$ denotes the aggregate level of total factor productivity and it is assumed to grow at an exogenous factor $\gamma_A$>1 and $\tau_c$ are corporate taxes.

Feasibility in the goods market sector requires that the total expenditures from each type of agent in all markets add to GDP. Namely, that

$$P_F F + P_{NF}NF + P_I I + X_m + X_h = K^\theta_m(AL_m)^{1-\theta}.$$

A **competitive equilibrium** for this economy is a sequence of prices and allocations for the partnership and single households that solve the corresponding optimization problems, taking prices as given. For it to be an equilibrium all of the aggregate resource constraints and market clearing conditions must also be satisfied.

## 4.1 Calibration

We set the values of the parameters so that the balanced growth equilibrium time series match some of their counterparts in the U.S. data during the period 1955-65. Then, we feed into the model the observed changes in the U.S. tax system as well as the gender wage gap between male and female workers to represent the 1990s. A new balanced growth equilibrium emerges and our quantitative analysis compares this new balanced growth equilibrium time series to its corresponding U.S. data counter parts for the period 1995-04.

Estimates of the intertemporal elasticity of substitution found in the literature imply values for $\sigma$ within the interval [1,2]. In our baseline experiment we pick an intermediate value $\sigma = 1.5$.. Some parameters of the model are straightforward to calibrate. We set the depreciation rate for capital at 6%, the discount factor $\beta$ so that the interest rate matches the average 4% of the data, and the parameter of the aggregate production function for the market good $\theta$ such that the share of income going to labor matches its data counter part, $\theta$=0.34. The growth factor of the exogenous technology parameter $A_t$ is set at $\eta_A$=1.02 so that the model matches the 2% average growth rate of per-capita GDP of the U.S. economy. The growth factors of relative prices of purchased meals and groceries have been stable over the last 40 years and are set at their average $\eta_{P_F}$=1.007 and $\eta_{P_I}$=1 . The relative prices of investment goods in general and those used for preparing food at home (kitchen and other household appliances in the U.S. NIPA) have declined at a relatively steady rate during the last 40 years. We set the model's parameters to match the observed average rates in the data, $\eta_{q_h}$=1.028.

The price elasticity of demand for restaurant meals has been estimated equal to 2.3 by Anderson et. al. and we set $\gamma$ so that model's elasticity matches such value. The elasticity of substitution between female and male time in the production of home meals, determined by $\rho$ in our model, is assumed equal to the elasticity of substitution in the production of all household goods reported by Aguiar and Hurst (2005). In the base line experiment we let $\zeta_3 = 0.9$, which implies a high elasticity of substitution between cooking capital and the

composite time-ingredients.

Regarding married households, there are seven parameters to be calibrated $\alpha, \nu, \mu, \zeta_0, \zeta_1, \zeta_2$ and $\lambda_f$. Their values are jointly determined from steady state equations so that the model matches the U.S. averages for 1955-65 on: hours worked and hours preparing food from tables 1A and 1B (4 observations for married households), a ratio of aggregate expenditure in consumption other than food[11] to food away from home equal to 18, a ratio of aggregate expenditure in ingredients[12] to food away from home of three, and a ratio of the number of meals eaten at home to meals eaten away from home equal to five. The five parameters associated to the single households $(\alpha, \nu, \mu, \zeta_0, \zeta_2)_{s,i}$ are calibrated to match hours worked and preparing food of single adults (two observations each) and the three ratios of aggregate data used for the married households.

## 4.2 Results from the Benchmark Model

We assume the 1960s constituted a balanced growth path of the U.S. economy and compare it to a different balanced growth equilibrium reached towards the end of the 1990s, which is characterized by lower values of the personal income tax rate and the gender wage gap. In particular, we compare the equilibrium of the 1960s with $\tau_d$=0.43 to one where $\tau_d$=0.24 with the average tax rates reported in Table 3. The benchmark experiment assumes $\rho$=0.25 and $\gamma$=0.6. Tables 5 and 6 report the model's predictions regarding time use and expenditures on th different types of food consumption of food.

[11]Consumption other than food is measured from the NIPA as Nondurable consumption expenditure + Government expenditure + Net exports - Food expenditure (the latter from the detailed personal consumption expenditure tables of the BEA)

[12]Ingredients correspond to food purchased for off premise consumption in the detailed personal consumption expenditure tables of the BEA.

| **Households** | **% Change Model** | **% Change Data** |
|---|---|---|
| **Married couples** | | |
| Hours worked (female) | 120% | 108% |
| Hours worked (male) | -8% | -1% |
| Hours food prep. (female) | -29% | -50% |
| Hours food prep. (male) | 3% | 35% |
| **Single females** | | |
| Hours worked | 35% | 10% |
| Hours food prep. | -70% | -46% |
| **Single males** | | |
| Hours worked | 1% | 0% |
| Hours food prep. | -5% | 0% |

TABLE 5: TIME USE (WEEKLY) FOR THE BENCHMARK MODEL.

Qualitatively speaking, the predictions of the model with respect to time use for the different types of households are consistent with the data, except for the time use of single males. Quantitatively the model over predicts the decrease in the number of hours worked by married as well as the increase in the number of hours worked by both single households and married females.

| **Aggregate Economy** | **% Change Model** | **% Change Data** |
|---|---|---|
| Exp. Groceries | -30% | -46% |
| Exp. Food Away from Home | 56% | 40% |

TABLE 6: PER CAPITA REAL ANNUAL EXPENDITURES FOR THE DIFFERENT TYPES OF FOOD RELATIVE TO A 2% TREND.

The predictions of the model with respect to the consumption of food away from home, prepared meals and home cooked meals are also qualitatively consistent at the aggregate level.[13] In particular, the model overpredicts the increase in expenditures of food away from home and explains two thirds of the decrease in the expenditures of groceries. This version of the model predicts that single females are the ones whose consumption of prepared food should have increased the most. This implication is qualitative consistent with the PSID which shows that single female and married households are the types of households have increased the consumption of prepared food the most.

[13]We compute the aggregate economy as the weighted sum of the total expenditures for each type of household in the economy. The weights are the average fraction of households of each type, taken from the current population survey from 1962 to 2000. In particular, we have that for the period considered the composition of the U.S. is such that 78% of the households are married, 15% are single females and 7% are single males.

| Aggregate Economy | % Change Model | % Change Data |
|---|---|---|
| From Groceries | 24% | -4% |
| From Food Away from Home | 106% | 67% |

Table 7: Per capita Total daily calories of different types of foods and gender for the benchmark model.

With respect to increased calorie consumption the benchmark model overpredicts the calories from groceries and from food away from home. The predictions of the model with respect to food eaten away from home are qualitatively consistent with previous empirical findings, being one of the major factors explaining the increased obesity in the U.S.

***The Role of Taxes and the Gender Wage Gap***

In this section we determine the relative importance of taxes and the gender wage gap in accounting for the obesity trends in the U.S. over the last thirty years.

As we have seen, changes in taxes and the gender wage gap during the 1990s are key elements in explaining the increased opportunity cost of cooking at home. The two main channels considered in this paper are not symmetric in terms of their effects on the opportunity costs faced by men and women. Changes in taxes affect both genders in a similar fashion. The potential asymmetry of the tax channel is that different households may face different tax rates depending on their income. As a result, the tax reform may affect differently single as well as married households. On the other hand, a change in the gender wage gap directly affects the opportunity cost of women. This asymmetry is especially important for married households since it implies different degrees of specialization in home production. Moreover, it can also help explain the different consumption and leisure patterns observed among the different single households.

The natural experiment we consider is to only consider changes in taxes and compare its predictions to the previous ones. By doing so we can determine the relative importance of taxes and the gender wage gap in accounting for the obesity trends in the U.S. over the last thirty years.

| Households | % Change Model | % Change Data |
|---|---|---|
| **Married couples** | | |
| Hours worked (female) | 24% | 108% |
| Hours worked (male) | 3% | -1% |
| Hours food prep. (female) | -7% | -50% |
| Hours food prep. (male) | -8% | 35% |
| **Single females** | | |
| Hours worked | 9% | 10% |
| Hours food prep. | -31% | -46% |
| **Single males** | | |
| Hours worked | 1% | 0% |
| Hours food prep. | -5% | 0% |

TABLE 8: TIME USE (WEEKLY) ON THE BENCHMARK MODEL ONLY CONSIDERING TAXES.

As we can see, from Table 8 taxes alone can not fully account the time use observed in the data. In particular, it can only explain 22 per cent of the increased number of working hours and 14 per cent reduction in the number of hours cooking and food preparation by married females. Taxes alone do not predict the type of specialization as the one observed in the data.

With respect to the consumption of the different consumption choices that agents in the economy face when only the effect on taxes are considered we find that the overall effect is much smaller, see Table 9.

| Aggregate Economy | % Change Model | % Change Data |
|---|---|---|
| Exp. Groceries | -10% | -46% |
| Exp. Food Away from Home | 37% | 40% |

TABLE 9: PREDICTIONS OF THE MODEL IN TERMS OF EXPENDITURES ONLY CONSIDERING TAXES.

Once again taxes alone can not fully account the patterns in expenditures observed in the data. Taxes alone can only account 22 per cent of the decreased expenditures in groceries. The fact that women both married and single face different opportunity costs than men has an important consequences on the food choices that households make.

| Aggregate Economy | % Change Model | % Change Data |
|---|---|---|
| From Groceries | 60% | -4% |
| From Food Away from Home | 80% | 67% |

TABLE 10: PER CAPITA DAILY CALORIES OF DIFFERENT TYPES OF FOODS AND GENDER ONLY CONSIDERING TAXES.

As we can see from table 10 taxes alone can account only for a **?%** of the change in the total calories consumed. The increased opportunity cost faced by women due to a decrease in the gender wage gap increases the demand for food that requires less or no cooking time, which in turn results in more calories.

We can conclude then that the narrowing of the gender wage gap between male and female workers is an important element when accounting for the increased calorie consumption over the last 30 years in the United States. In particular, the asymmetric nature of the gender wage gap is a necessary component when explaining the observed specialization in home production within married households as well as the different consumption and leisure patterns observed between single male and female households.

# 5 Additional Evidence

It is beyond the scope of the present paper to consider heterogeneous agents within each household, although it would be an interesting exercise. In this section we suggest that an extended version of the current model with heterogeneous agents within each type of household would have the potential to explain some other features of the data for various subgroups of the U.S. population. In order to do so, we present some additional evidence supporting the mechanism presented in this paper. In particular, the mechanism that we propose is as follows: A decline in the personal income tax rate increases the after tax wage. Thus, it increases the opportunity cost of using time to prepare food at home for both, men and women. Similarly, a decline in the gender wage gap increases the average wage of women, and hence her cost of preparing food at home. If eating at home and eating away from home are substitutes, a decline in either the personal income tax rate or in the gender wage gap will increase the consumption of food away from home.

With respect to the channel examined in this paper, Hamermesh (2005) using time-diary and expenditure data for the U.S. for 1985 and 2003, examines how incomes and time prices affect time and goods inputs into this household-produced commodity. He demonstrates that both inputs into food increase with income, and that higher time prices at a given level of income reduce time inputs. This would suggest that the highest increase in calories would be observed with the highest income groups which is also the group with the highest opportunity cost. This is exactly what is observed in the data and is consistent with channel

presented in this paper.

Regarding childhood obesity, Anderson, Butcher and Levine (2003) find that a child is more likely to be overweight if his/her mother worked more intensively (in the form of greater hours per week) over the child's life. This effect is particularly evident for children of white mothers, of mothers of higher education, and of mothers with a high income level. This evidence is consistent with our mechanism since this increase in childhood obesity is largely due to the higher opportunity cost of cooking by their mothers.

At a global level, Cutler, Glaeser and Shapiro (2003) present some international evidence showing that the percentage of the population that is obese is positively related to income per capita and percentage of female labor force participation. These empirical findings also suggest the importance of considering the opportunity cost of women when studying the increased obesity world wide.

Regarding obesity within different income groups, Zhang and Wang (2004) find that during 1971 to 2000 the group of U.S. adults that has increased obesity rates the most have been the ones with the highest education level both for men and women, see Table 11.[14]

| | **1970s** | **1990s** | **% Change** |
|---|---|---|---|
| **Females** | | | |
| Low education | 24.9 | 37.8 | 52% |
| Medium education | 14.8 | 34.5 | 133% |
| High education | 7.3 | 29.9 | 309% |
| **Males** | | | |
| Low education | 12 | 26.7 | 123% |
| Medium education | 14.4 | 29.4 | 104% |
| High education | 7.4 | 24 | 219% |

Table 11: Obesity rates among U.S. adults by gender and education level.

As we can see from Table 14, the different groups that have increased obesity the most have been the groups that have seen their opportunity cost increased the most too. These findings are also consistent with the mechanism suggested in this model.

Finally, one of the main factors causing the increased weight of American adults according to our theory is the observed decline in the gender wage gap. Blau (1998) finds that the relative gender wage gap for adults with low education levels has declined far less than that

[14]The data for this study is taken from the National Health and Nutrition Examination Surveys. The authors define low education as less than high school, medium education as high school education, and college or above as high education.

of adults with high education levels. The gender wage gap over 1969-1994 for individuals with less than 12 years of education declined by 19.67%, while the one for more than 12 years of education declined by 25%. Thus, the groups of individuals for which the gender wage gap has declined the most are also the groups where obesity rates have increased the most. These observations are also consistent with the increased opportunity cost in explaining the increase in obesity in the U.S. over the last forty years.

# 6 Conclusions

This paper examines the relation between taxes, the gender wage gap and the consumption of food away from home, which can account for the increased weight over the last 40 years in the United States. In particular, it includes the explicit distinction between men and women, either single or married (or in a partnership). All agents care about food items (prepared at home or purchased away from home), non-food items and leisure. Eating at home demands time, capital and groceries. Market goods require quality adjusted work to be produced. Agents in this economy are price takers and interact in markets for labor, capital, investment and market consumption.

A calibrated version of the model indicates that the observed changes in the personal income tax rate and in the gender wage-gap must be a part of any theory searching to explain the allocation of time, food consumption and the increased obesity rates of American households. The model requires some degree of substitution between food away from home and foods eaten at home, some degree of substitution between female and male cooking hours as well as some complementarity between groceries and cooking labor to match U.S. observables. Moreover, the U.S. data suggest that the technological advancements in the production of food have been overshadowed by those in the production of durable goods and services. Americans consume more food away from home in spite of a relatively strong increase in its relative price. This finding emphasizes the high opportunity cost of cooking at home, which helps explain the increase in obesity over the last 30 years.

# 7 Appendix

- In this model we consider a balanced growth path for the period 1955-65 as well as a new balanced growth equilibrium for the period 1995-04 which incorporates the observed changes in the U.S. tax system and the gender wage gap between male and female workers.

- The data corresponding to the relative price of food relative to the GDP deflator was computed by authors. In particular, we considered the price indexes and the personal consumption expenditures by type of expenditure, Table 2.5.4 and 2.5.5, as well as the price indexes for the gross domestic product, Table 1.1.4, from NIPA.

- The data on hours worked are taken as the middle point of interval hours from the integrated public use micro-data series version 3.0 from University of Minnesota for 1960 and 1990 and for individuals between the ages of 18 and 65.

- The data on the average number of weekly hours devoted to food preparation and clean up is taken from Cutler, Glaeser and Shapiro (2003).

- The per capita expenditures are obtained from the NIPA detailed personal consumption expenditures by type of product, Table 2.4.5, relative to the GDP.

- The total caloric intake for each type of food is computed by the authors. In particular, we use NHANES data which reports the number of calories by gender for the 1971-74 and 1989-94 periods. Total calories reported in the paper are the average from males and females. For the 1965 period we assumed that the total and the composition of calories are equal to the one in the 1971-74 period which is an upper bound estimate for the calories consumed in that period. In order to determine the number of calories from groceries and from food away from home, we use the data taken from Lin, Guthrie, and Frazao (2002), Figure 2, which reports the fraction of calories due to food away from home and to home meals.

- The personal marginal income tax rates are computed by authors. In particular, we used the Individual Income Tax Returns, Table R, for the 1960 to determine household composition according to marital status. From the U.S. Census Bureau IDB Data Access Table 0.47 we can determine the fraction of single males and females in 1960

and from Bar and Leukhina (2005) we can find the married composition regarding labor employment. We then used Table 13 and Table 4 part 2 of the Individual Income Tax Returns for the 1960 according to marital status to determine the fraction of total income due to salaries and wages so we can compute the average salary per person as well as the average hourly wage taking into account the average number of working hours reported by Table 1A of our paper as well as the observed wage gap between male and female. Once the average wage salary is known, using Table 4 part 2 of the Individual Income Tax Returns for the 1960 we can compute the average income. Finally, we computed the appropriate marginal tax rates according to marital status by examining the relevant tax brackets. Identical procedures and data sources were used to compute the tax rates for the year 2000.

The capital tax is computed as the weighted average of the different marginal income tax rates by gender and marital status. Finally, we used Table 1.13 from NIPA to compute the corporate tax which corresponds to the average taxes of production as the fraction of total output. Identical procedures and data sources were used to compute the tax rates for the year 2000.

- The price of kitchen and other household appliances is taken from NIPA from Table 2.3.4U relative to the GDP deflator.

# References


[1] Anderson, P., K. Butcher and P. Levine (2003) "Maternal Employment and Overweight Children", *Journal of Health Economics*, 22, 477-504.

[2] Aguiar, M., and E. Hurst (2005) "Measuring Leisure: Evidence from Five Decades of Time Use Surveys", *manuscript*.

[3] Anderson, P., R. McLellan, J. Overton and G. Wolfram (1997): "The Universal Tuition Tax Credit: A Proposal to Advance Parental Choice in Education," Mackinac Center for Public Policy.

[4] Bar, M. and O. Leukhina (2005) "To Work or Not to Work: Did Tax Reforms Affect Labor Force Participation of Secondary Earners?", *manuscript*.

[5] Becker, G. (1965) "A Theory of the Allocation of Time", *Economic Journal*, 75, 493-517.

[6] Blau, F. (1998) "Trends in the Well-Being of American Women, 1970-1995", *Journal of Economic Literature*, 36, 112-165.

[7] Chagnon Y., T. Rankinen, E. Snyder, S. Weisnagel, L. Perusse, C. Bouchard (2003) "The Human Obesity Gene Map: the 2002 Update", *Obesity Research*, 11(3), 313-67

[8] Cutler, D., E. Glaeser, and J. Shapiro (2003) "Why Have Americans Become More Obese?", *Journal of Economic Perspectives*, 17(3), 93-118.

[9] Greenwood, J., Z. Hercowitz and P. Krusell (1997):"Long-run Implications of Investment Specific Technological Change", *American Economic Review,* 87(3): 342-62.

[10] Goldin, C. (1990): *Understanding the Gender Wage Gap*, Oxford University Press, New York, NY.

[11] Gronau, R. (1977) "Leisure, Home Production and Work– The Theory of the Allocation of Time Revisited", *Journal of Political Economy*, 85, 1099-1124.

[12] Hamermesh, D. (2005):"Time to Eat: Household Production Under Increasing Income Inequality", *Working paper.*

[13] Jones, L., R. Manuelli and E. McGrattan (2003) "Why Are Married Women Working So Much?", *Federal Reserve Bank of Minneapolis Staff Report*, 317.

[14] Lakdawalla, D., and T. Philipson (2002) "The Growth of Obesity and Technological Change: A Theoretical and Empirical Examination", *NBER Working Paper*, No. w8946.

[15] Lin, H., J. Guthrie, and E. Frazao (2002) "Role of Food Prepared Away from Home in the American Diet 1977-78 versus 1994-98: Changes and Consequences", *Journal of Nutrition Education and Behavior* 34, 140:150.

[16] National Heart, Lung, and Blood Institute, National Institutes of Health (2000). "The Practical Guide: Identification, Evaluation, and Treatment of Overweight and Obesity in Adults" *NIH Publication* No. 00-4084.

[17] Posner, R., and T. Philipson (2003) "The Long-Run Growth in Obesity as a Function of Technological Change", *Perspectives in Biology and Medicine*, Supplement, S87.

[18] Prentice, M., and A. Jebb (2003) "Fast Foods, Energy Density and Obesity: A Possible Mechanistic Link", *Obesity Reviews* 4, 187-194.

[19] Young, L., and M. Nestle (2002) "The Contribution of Expanding Portion Sizes to the U.S. Obesity Epidemic", *American Journal of Public Health*, 92, 246-249.

[20] Zhang, Q., and Y. Wang (2004) "Trends in the Association Between Obesity and Socioeconomic Status in the U.S. Adults: 1971 to 2000" *Obesity Research* 12, 1622-1632.