

A Macroeconomic Analysis of Obesity in the U.S.*

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Abstract

We perform a dynamic general equilibrium analysis of the observed increase in the average weight of American adults during the last 40 years. Data suggests that this increase in weight can be attributed to a dramatic rise in the consumption of foods prepared away from home, which resulted in higher caloric intake. We study the quantitative implications of two different hypotheses that may help explain the increased consumption of foods prepared away from home: technological advancements in the production of processed food that lowered its price, and higher opportunity cost of cooking at home driven by lower taxes and gender wage gap. According to our model, actual trends in the gender wage gap and income taxes alone can account for almost all of the observed changes in calorie consumption, expenditure in food away from home, ingredients for cooking at home, consumption of non-food items, investment, and GDP. When taxes and the gender wage gap are held constant, technological advancements in the production of foods prepared away from home can only account for half of the food expenditure patterns in the data, and deliver counterfactual implications for key macroeconomic variables.

JEL Classification: D13, E2.

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1 Introduction

The steepness of the rate of increase in the weight of American adults over the past forty years is surprising. According to the National Health Examination and the National Health and Nutrition Examination surveys, the average weight of an American adult female has increased by 14 pounds

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since the early 1960s, from 140 to 154 pounds. Similarly, the average weight of an adult male has increased by 16 pounds, from 166 to 182. During the same time period, the average height of adult females and males has only increased by one inch, which cannot account for the observed increase in weights. 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, such as increasing the chances of suffering cancer, heart disease, and diabetes.¹ Understanding the underlying causes of the rapid increase in obesity rates over the last forty years is paramount to the debate over policies meant to reserve it.

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. Daily calories consumed by the average American adult have increased by 236, from 1996 in 1971-74 to 2232 in 2000. Such increase in calories consumed are, according to the estimates of the authors, more than enough to account for the observed changes in the average weight. Finally, it is important to mention the findings of Lin, Guthrie, and Frazao (2002) that suggest that all of the observed increase in caloric intake by the average U.S. household can be explained by a dramatic rise in the consumption of foods prepared away from home (or processed foods hereafter), and, to a lesser extent, by the increase in the number of calories found in meals prepared away from home. Thus, these studies suggest that the most important factor accounting for the increased weight of American adults is the rise in the consumption of foods prepared away from home.

In this paper, we study the quantitative implications of two different hypotheses that may explain the increased consumption of foods prepared away from home during the last forty years. The first hypothesis we consider is based on the idea that a technological revolution in the mass preparation of food has pushed the price of processed food down. Moreover, as meals based on processed foods require less preparation time than meals prepared from scratch, such technological revolution provided the economic incentives to consume more processed foods, and to cook less. The second hypothesis we evaluate suggests that lower income taxes and gender wage gap have translated into higher opportunity cost of cooking at home, which caused households to substitute home made meals for foods prepared away from home.

Cutler, Glaeser, and Shapiro (2003) suggest that a technological revolution in the mass preparation of food took place during the last decades. This technological revolution translated into a dramatic decline in the time cost and market price of food, particularly mass prepared foods. According to the authors, the lower time cost and increased availability of processed foods are behind the dramatic decline in cooking times and home meals, and also behind the higher consumption of processed food observed in the data. In turn, higher consumption of processed food, and the resulting increase in

¹See the National Heart, Lung, and Blood Institute, National Institutes of Health (2000) report for more on this issue. The standard definition of obesity is a BMI (body mass index which is weight divided by height squared) over 30 kg/m^2 . 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.

caloric intake then caused the higher weights and obesity rates of American households.²

The hypothesis that changes in opportunity cost of time are behind the increased consumption of food prepared away from home is based on a large body of empirical literature that documents a high positive correlation between different measures of opportunity cost of the household manager and the expenditure and frequency of consumption in meals prepared away from home.³ Microeconomic studies have established the importance of the increased opportunity cost of time in explaining food expenditures patterns of households. In particular, Jensen and Yen (1996) investigate household expenditures on food away from home by type of meal in the U.S. based on a household production framework that accounts for constraints on the availability of time as well as income. The authors find that the effects of wife's employment are significant and positive on both the consumption frequency and level of expenditures on lunch and dinner away from home.⁴

Our quantitative analysis, based on a dynamic general equilibrium model that builds on Becker's (1965) theory of household production, provides an explicit mechanism driving the increase in opportunity cost of time, and links the latter to higher consumption of food prepared away from home. The model economy is constituted by households, which derive utility from food, non-food consumption goods, and leisure. Food can be prepared at home from scratch, but its preparation requires cooking time and groceries. Food prepared away from home can be purchased from the market and is a substitute of meals prepared from scratch. Households maximize utility taking as given market prices, the gender wage gap, and income tax rates. The economy also has two production sectors. One sector produces food prepared away from home. The other sector produces an aggregate good that can be used for non-food consumption items, or investment of any type. Following the existing economic literature, we take the calorie content of different types of foods as given from the U.S. data.

Available evidence shows that married females are the group that has gained the most weight during the last forty years, followed by single females, married men, and single men. A lower gender wage gap has a direct implication on women, raising their opportunity cost of cooking time. Moreover, because of the possibility of specialization within the household, a lower gender wage gap may affect married and single females very differently. To capture these asymmetries, and to be able to study the observed trends in obesity rates by gender and marital status, our analysis includes an explicit distinction between men and women, either single or married. The structure of our model is closely related to the general equilibrium analysis of Jones, Manuelli and McGrattan (2003), who find that actual changes in the gender wage gap can account for most of the observed changes in hours worked of married women.

We then examine the quantitative implications of each one of the aforementioned hypotheses for

²Moreover, it has been argued that individual's self-control problems and changes in social norms related to body-weight have the potential of exacerbating the impact of lower food prices on food consumption and weight; see for example Burke and Heiland (2006).

³See for example, Prochaska and Schrimper (1973) for an early contribution and Byrne, Capps, and Saha (1996), and Dong, Byrne, Saha and Capps (2000) for more recent analysis.

⁴Similarly, Mutlva and Gracia (2006) find that income, household characteristics and the opportunity cost of women's time are important factors determining food consumption patterns away from home in Spain. Moreover, income and opportunity cost of women's time have a positive effect on the consumption of food prepared away from home.

caloric intake, expenditures in food away from home and in groceries for preparing food at home, non-food consumption items, cooking times, and a set of key macroeconomic aggregates. We find the hypothesis based on changes in income taxes and the gender wage gap alone to be the most successful overall. Surprisingly, when food technology is held constant, actual changes in income tax rates and in the gender wage gap can account for 78% of the increase in calorie consumption as well as the trends in expenditures on food away from home, groceries, non-food consumption goods, aggregate investment, and GDP present in the U.S. data. The model can also account for the observed decline in cooking times as well as for the entire 2-fold increase in hours worked of married females. These findings suggest then that increased weights are not surprising but, rather, a natural household response to the observed changes in the opportunity cost of time.

When taxes and the gender wage gap are held constant, technological advancements in the food away from home sector can make the model match either the observed drop in aggregate cooking times, or the higher expenditure in food away from home, or the observed decline in expenditures on groceries. What the model cannot do is to account jointly for expenditure trends in food items and cooking times. The model also falls very short of accounting for the increased consumption of non-food items present in the data. Moreover, relative to a 2% trend, advancements in the production of food away from home also imply a decline in per-capita GDP and investment of at least 2% that is not consistent with the corresponding U.S. data where GDP increased by 12% and investment by 38%.

It is important to note that the existing empirical evidence, and a key feature of existing explanations for the observed increase in obesity rates, suggests that people eat more calories when consuming foods prepared away from home than when consuming home made meals. A growing body of papers in the nutrition literature reaffirms this fact and has proposed several mechanisms to rationalize it. Young and Nestle (2002) suggest that increased portion sizes are one of the key elements in explaining the increased obesity epidemics in the U.S. In their study they sample foods sold for immediate consumption in the most popular take-out establishments, fast-food outlets, and family-type restaurants. Their data indicates that the sizes of current marketplace foods almost universally exceed the sizes of those offered in the 1970s.⁵ Moreover, Lin, Guthrie and Frazao (2002) have shown that foods prepared away from home tend to be 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 eat more on high energy density (high fat) than low energy density diets - a phenomenon known as “hyperphagia.” These studies then suggest that it does not take a disproportionate amount of food to ingest more calories when eating away from home or eating prepared foods.

The rest of the paper is organized as follows. Section 2 presents a summary of some of the key

⁵When 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.

data features we want to explain, as well as some of the observations required to calibrate our model. The model and main results of the paper are presented in Section 3. Section 4 concludes.

2 Background Data

In this section we document facts about: (i) food expenditures and calories consumed by each type of food we consider in this study, (ii) time use (including labor supply and cooking and clean up times), (iii) the gender wage gap, (iv) marginal income tax rates on labor and capital incomes by gender and marital status, as well as the tax rate on profits, and (v) available aggregate data on food prices.

Table 1A reports real per capita annual expenditures, relative to a 2% average growth rate, for the two periods considered in the model. As a result of the different frequencies at which data is collected the periods reported in the tables below may not always coincide. However, closest periods were always considered. Sensitivity analysis to period selection was performed whenever possible finding always similar results to the data reported below. See the Appendix for the sources and computations involved in this and all of our data tables.

Aggregate economy	$\Delta\%$ (1955-65 to 1995-04)
Exp. Groceries	-40%
Exp. Food Away from Home	41%
Exp. Non Food	19%
GDP	13%
Investment	38%

Table 1A: Per capita real annual expenditures for the different types of goods relative to a 2% trend.

Table 1A, indicates a significant shift in the expenditure patterns of American households over the last 40 years. In particular, per capita real expenditures on groceries have decreased by 40% relative to a 2% trend. On the other hand, expenditures on food away from home have increased by 41% relative to a 2% trend.

Table 1B reports the per capita daily calories of different types of foods by gender for the periods considered in this model.

Aggregate economy	1965	1995	$\Delta\%$
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 1B: Per capita total daily calories of different types of foods and by gender.

The data in Table 1B suggests that the increase in calories observed between 1965 and 1995 was driven by the increase in calories consumed from food away from home. Notice also that the percentage increase in total calories consumed by female adults is twice as big as that of males.

Table 2A reports a summary of the hours worked by marital status and gender, and Table 2B reports the time devoted to food preparation and clean up, also by gender and marital status.

Households	1960	1990
Married couples		
Hours worked (female)	10.7	22.2
Hours worked (male)	39.4	38.9
Single females		
Hours worked	22.4	24.7
Single males		
Hours worked	27.9	27.8

Table 2A: Average number of weekly working hours by gender and marital status.

The most striking features from Table 2A are, first, that the average number of hours worked by married women has more than doubled. Secondly, single women work 10% more now than during the 1960s. Finally, 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)	13.0	6.4
Hours food prep. (male)	1.2	1.7
Single females		
Hours food prep.	7.0	3.8
Single males		
Hours food prep.	2.1	2.1

Table 2B: 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 2B 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. Married men devoted an almost insignificant amount of time to food preparation activities during the 1960s (less than 11 minutes per day). Married men devoted 30% more time to food preparation during the 1990s, but in absolute terms the time they allocate to cooking is very small (15 minutes per day).

The data reported on Tables 2A and 2B play an important role in our analysis. The 1960s data is used to calibrate some of the parameters of the model. Moreover, Tables 2A and 2B are also used to confront the 1990s time-use predictions from the model to the observations of the U.S. economy.

The size and nature of the “gender wage gap” has been well-documented, see Goldin (1990). 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; see Jones, Manuelli and McGrattan (2003).

One of the key mechanisms driving the shift in consumption and the increased obesity rates of all households explored in this paper is the increased opportunity cost of cooking at home. Changes in taxes are going to be important and will be directly incorporated into the model as reported in Table 3. Household taxes in this table correspond to the effective marginal tax rates for the average household by marital status and sex; see the Appendix for more details.

Effective Tax Rates	1955-65	1995-04
Households		
Labor income for married couples	22%	15%
Labor income for single females	22%	15%
Labor income for single males	22%	22%
Capital income	22%	15%
Firms		
Profits	43%	35%
Social security contributions	1%	4%

Table 3: Marginal corporate and personal income tax rates by gender and marital status.

The tax reform Act 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 marginal tax rates fall the most. Finally, taxes on profits have declined during our sample period, which in a competitive equilibrium translates into higher rates of return for capital. All of these changes have important implications on the opportunity cost of cooking at home for the different households.

For completeness, we also report in Figure 1 the trends in existing data on the price of groceries (labeled food for off-premise consumption in the U.S. NIPA), and the price of food prepared away from home relative to the GDP deflator. The relative price of groceries declined almost monotonically from 1955 until 1973 when it jumped up by almost 15%. It remained high all through the mid 1970s and early 1980s. By 1982 the relative price of groceries was back at its 1972 level. From 1982 to the present

this price has remained relatively constant. On the other hand, the aggregate price of food away from home has increased over the period examined. Of course, aggregate price indexes reported by the U.S. NIPA may not fully adjust for changes in portion sizes, nor quality. Data on changes in portion size of the aggregate “food prepared away from home” through time is not available. Given that Young and Nestle (2002) find evidence that there has been substantial increase and variance regarding portion size of many processed food items since the 1970s, we cannot make precise quantitative assessments of the price of food away from home.

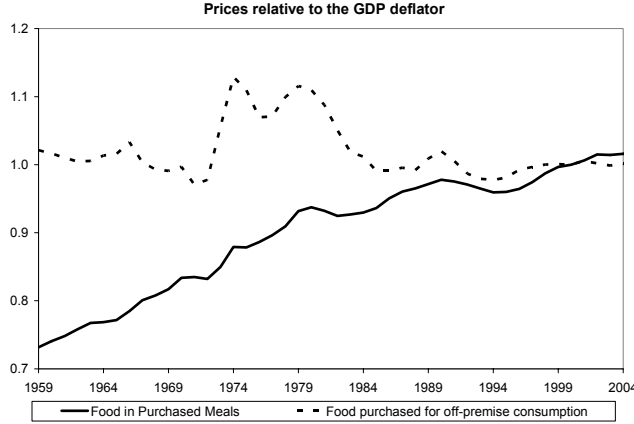


Figure 1: Price of food relative to the GDP deflator.

3 The Model

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 taking the prices of food as given. Households must also decide how much to spend on groceries for cooking food at home, on meals prepared outside the home and on other non-food items. We make the simplifying assumption that agents choose the types of meals they consume (prepared at home from scratch or away) but not the number of calories they consume. 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 a tax wedge that differs by gender. Households are the owners of capital, and they rent it to firms at a competitively determined interest rate.

Married Households

We now present 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 of food, C_F , other consumption goods, C_{NF} , and leisure streams, $\hat{L} - L_h - L_m$, can be

represented by:

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

$$\left. (1-\lambda_f) \left(\alpha (C_{F,t}^{pm})^{1-\sigma} + \nu (C_{NF,t}^{pm})^{1-\sigma} + (1-\alpha-\nu) \left(\hat{L} - L_{h,t}^{pm} - L_{m,t}^{pm} \right)^{1-\sigma} \right) \right\};$$

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 , and 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.⁶ The relative weight of the woman's utility in a partnership is λ_f , β is the discount factor, n denotes the population growth rate and σ , α and ν 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_F^p , obtained through foods prepared away from home (F^p) and home meals (HF^p), is given by:

$$C_{F,t}^p = C_{F,t}^{pf} + C_{F,t}^{pm} = (\mu_1 (F_t^p)^\gamma + (1-\mu_1) (HF_t^p)^\gamma)^{1/\gamma}; \quad (2)$$

where γ denotes the degree of substitution between foods prepared away from home and home prepared meals, and μ_1 represents the relative importance of food away from home. Home meals are produced using groceries, I^p , together with female and male cooking labor, L_h^{pf} and L_h^{pm} , respectively. We assume that time is complementary with groceries in the production of food. In particular, we have:

$$HF^p = \min \left[I^p, \zeta_0 (L_h^{pf})^{\zeta_1} (L_h^{pm})^{1-\zeta_1} \right]; \quad (3)$$

where ζ_1 is the share of female cooking hours and ζ_0 is a conversion factor between groceries and labor cooking hours.

Consumption goods other than food are acquired in the market. Total consumption of non food items of the partnership is denoted by:

$$NF_t^p = C_{NF,t}^{pf} + C_{NF,t}^{pm}. \quad (4)$$

Households can also invest in the capital stock used in market activities, k_m^p , as well as in capital specific for the food away from home sector, k_f^p . These capitals evolve over time according to:

$$k_{m,t+1}^p = X_{m,t}^p + (1-\delta)k_{m,t}^p \quad (5)$$

$$k_{f,t+1}^p = X_{f,t}^p + (1-\delta)k_{f,t}^p; \quad (6)$$

⁶Time-use studies show that Americans sleep 8 hours per day [9]. 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.

where X represents investment, and δ denotes the depreciation rate. Finally, households face the typical budget constraint given by:

$$P_{F,t}F_t^p + NF_t^p + I_t^p + X_{m,t}^p + X_{f,t}^p + R_t b_t^p \leq \quad (7)$$

$$(1 - \tau^p) \left(w_t((1 - \tau_d)L_{m,t}^{pf} + L_{m,t}^{pm}) \right) + (1 - \tau_k) \{ (1 - \tau_c)(r_{t+1} - \delta) + \delta \} [k_{m,t}^p + k_{f,t}^p] + b_{t+1}^p + T_t^p$$

where $L_m^{p,j}$ denotes hours devoted to market activities by the members in the partnership for $j=f, m$; b^p are bond holdings, τ^p denotes the tax on labor income, $(1 - \tau_d)$ denotes the gender wage gap tax, and P_F corresponds to the price of food away from home relative to the GDP deflator. Following Hayashi (1982) and McGrattan and Prescott (2005), we map profits in the data to capital income in our model.⁷ The tax rate on profits is denoted by τ_c . The tax rate on capital income, τ_k , is assumed to be common for single and married agents households. The latter is a technical condition required so that all households hold a positive amount of capital in equilibrium.

We assume the relative price of groceries equal to one as data shows no significant change over the periods we consider. The wage rate is denoted by w , r corresponds to the rental rate on capital, R is the return on bonds, T^p are taxes rebated to households as lump sum transfers. To guarantee that the problem of the household is well defined, we restrict borrowing to be less than the present value of future wealth. Such a constraint does not bind along the balanced growth path.

Finally, this economy is also populated by representative single male and female households whose preferences and optimization problems are analogous to the partnership's problem.⁸

Technological Constraints and Aggregate Feasibility

Our economy has two representative competitive firms. One produces food away from home using capital and labor. Its production technology can be represented by:

$$K_f^{\theta_f} (A_f L_f)^{1-\theta_f}$$

The other representative firm produces non-food goods, investment and services with the Cobb-Douglas technology

$$K_m^{\theta_m} (A_m L_m)^{1-\theta_m}$$

In the above equations K_i , A_i , L_i and θ_i denote the capital, productivity, labor and capital share in sector $i=m, f$. Firms produce and rent productive inputs taking prices as given. Constant returns to scale in a competitive framework implies zero profits for each one of the representative firms. Moreover,

⁷Alternatively, one can write a model where firms are the owners of capital and pay dividends to households. Such a model results in equilibrium allocations identical to ours.

⁸The problem of the single female can be derived from the married households problem by setting $\lambda_f = 1$, and $\zeta_1 = 1$. Similarly, the problem of the single male sets $\lambda_m = 1$, and $\zeta_1 = 0$.

rental rates must equal marginal products, namely:

$$\begin{aligned} r &= \theta_f K_f^{\theta_f - 1} (A_f L_f)^{1 - \theta_f} = \theta_m K_m^{\theta_m - 1} (A_m L_m)^{1 - \theta_m} \text{ and} \\ w(1 + \tau_{ss}) &= (1 - \theta_f) K_f^{\theta_f} (A_f L_f)^{-\theta_f} = (1 - \theta_m) K_m^{\theta_m} (A_m L_m)^{-\theta_m} \end{aligned}$$

where firms are required to make social security contributions at rate τ_{ss} .

Market clearing in the food away from home sector requires that the demand of food away from home of all households, F , is equal to the available production. Namely:

$$F = K_f^{\theta_f} (A_f L_f)^{1 - \theta_f}$$

Similarly, market clearing in the second sector of the economy implies

$$NF + I + X_m + X_f = K_m^{\theta_m} (A_m L_m)^{1 - \theta_m}$$

In the previous market clearing conditions, capital letters with no super-index denote the corresponding aggregate variable (weighted by the fraction of the population).

Equilibrium

A *competitive equilibrium* for this economy is a sequence of prices and allocations for the partnership, single households, and firms that solve the corresponding optimization problems, taking prices as given. For it to be equilibrium all of the aggregate resource constraints and market clearing conditions must also be satisfied. A *balanced growth equilibrium* is an equilibrium where expenditures grow at constant rates and time use variables remain constant through time.

3.1 Some Theoretical Predictions

A closed-form solution for all equilibrium variables of this model cannot be obtained, except for very specific parameterizations. In this section we characterize the equilibrium behavior of some of the key variables of the model. Our purpose is to develop the economic intuition of the forces driving our results, which will help in obtaining a better understanding of the quantitative findings that we derive, numerically, in the following sections of the paper.

Proposition 1 *In any equilibrium, the following relationships must hold:*

$$L_h^{pm} = \left(\frac{(1 - \tau_d)(1 - \zeta_1)}{\zeta_1} \right) L_h^{pf} \quad (8)$$

$$\left(\frac{\hat{L} - L_h^{pf} - L_m^{pf}}{\hat{L} - L_h^{pm} - L_m^{pm}} \right)^\sigma = \frac{\lambda_f}{(1 - \lambda_f)(1 - \tau_d)} \quad (9)$$

$$\frac{\frac{\partial C_F^p}{\partial F}}{P_F} = \frac{\frac{\partial C_F^p}{\partial L_h^{pf}}}{(1 - \tau)(1 - \tau_d)w + P_I \zeta_0 f(\tau_d)}, \quad (10)$$

where $f(\tau_d) = \left(\frac{(1-\tau_d)(1-\zeta_1)}{\zeta_1} \right)^{1-\zeta_1}$.

From Proposition 1 we can derive the following partial equilibrium corollaries for partnership households:

Corollary (1): Lower taxes and/or a lower gender gap increase the consumption of food away from home and lower female cooking time.

Notice first that the denominator of the right hand side of equation (10) is the economic cost of female cooking time. The first term in this sum is the opportunity cost of time. The second term reflects the complementarity between ingredients and time: Higher cooking time has an additional indirect cost because it involves higher expenditure in ingredients.

The intuition behind the first corollary is that lower taxes or gender gap increase the economic price of cooking. Hence, the household has incentives to lower cooking time and to substitute home meals for prepared meals. Analytically, lower taxes or gender gap increase the denominator of the right hand side of equation (10). Notice that the partial derivatives of C_F^p are decreasing in F and in L_h^{pf} . Hence, to restore the equality, either L_h^{pf} has to decrease, or F has to increase, or both.

Corollary (2): Lower taxes translate into lower cooking times for males.

Holding the gender gap constant, equation (8) shows that cooking times are proportional to each other and, as stated in our first corollary, lower taxes lower cooking times for females.

Corollary (3): A lower gender gap has an indeterminate effect on the male's cooking time. The total impact is approximated by:

$$\Delta\%L_h^{pm} \approx \Delta\%L_h^{pf} + \Delta\%(1 - \tau_d).$$

A higher opportunity cost of female cooking time, via lower gender gap, motivates households into substituting female time by male cooking time. However, equation (8) also shows that lower female cooking pushes male cooking down (as cooking times are proportional). The result in corollary 3 is a straightforward implication of equation (8).

Corollary (4): A lower gender gap increases female market hours.

From Corollary 1, a lower gender gap lowers female cooking times. Moreover, equation (9) shows that a lower gender gap translates into lower female leisure. Hence, a lower gender gap pushes female market hours up.

As the previous corollaries illustrate, changes in taxes and the gender wage gap are key elements in explaining the increased opportunity cost of cooking at home. These theoretical results also show that changes in taxes and in the gender wage gap 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. 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 female and single male households.

In the next sections, we describe and perform the quantitative analysis. Our numerical results reveal that the channels presented in this section are also observed when all general equilibrium effects are considered.

3.2 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. Estimates of the intertemporal elasticity of substitution found in the macroeconomic literature imply values for σ within the interval [1,2]. In our baseline experiment we set a value of $\sigma = 1.5$. Some parameters of the model are straightforward to calibrate. We set the depreciation rate for capital at 6%, the discount factor β so that the interest rate matches the average 4% in the data. The parameter of the aggregate production function for the market good, θ_m , is set so that the share of income going to labor from the model matches its data counterpart, $\theta_m=0.34$. Similarly, parameter θ_f is such that the model matches the capital-labor ratio of the restaurant industry, which results in $\theta_f=0.08$. The growth factor of the exogenous technology parameter for the numeraire good is set at 1.02 so that the model matches the average growth rate of per-capita GDP of the U.S. economy.

There is a large body of empirical literature devoted to the analysis of food consumption choices of American households. A recent study by Piggot (2003) develops a nested empirical model including most of the commonly employed demand systems for food in the United States. The author reports values for the price elasticity of food away from home that range between -2.3 and -1.16. In our model, the price elasticity of food away from home is determined by parameter γ . We set at $\gamma = 0.87$ to match the middle point of the values reported by Piggot, i.e. a price elasticity of food of -1.73 .

Regarding married households, there are six parameters left to be calibrated: the weights in the utility of food and non-food consumption goods, which are given by α, ν , respectively; the weight of the female in the total household utility in the married household, given by λ_f ; and a set of food technology parameters μ, ζ_0 , and ζ_1 . The values of these parameters are jointly determined from steady state equations so that the model matches six U.S. averages for 1955-65. In particular, we match the hours worked and hours preparing food from Tables 2A and 2B (4 observations for married households), a ratio of aggregate expenditure in consumption other than food to food away from home equal to 18, and a ratio of aggregate expenditure in ingredients to food away from home of 3.⁹ The four parameters associated to the single households $(\alpha, \nu, \mu, \zeta_0)_{s,i}$ are calibrated to match hours worked and preparing food of single adults (two observations each) and the two ratios of aggregate data used for married households.

⁹Consumption 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). Ingredients correspond to food purchased for off premise consumption in the detailed personal consumption expenditure tables of the BEA.

3.3 Results

In this section we perform a quantitative analysis of two different hypotheses for the increased weight of American adults. All experiments depart from a common balanced growth path that we associate to the 1955-65 U.S. economy. We study each hypothesis independently, by feeding into the model an exogenous increase in the productivity of the production technology of food away from home, and, finally, the observed trends in income taxes and the gender wage gap. We compute the balanced growth equilibrium associated to each one of these changes and assume this new equilibrium corresponds to the 1995-04 U.S. data. We test the consistency of each hypothesis by contrasting the implications of the model to the data in the following dimensions: aggregate expenditure in food prepared away from home, in ingredients for preparing food at home, in non-food consumption, time use, and a set of key macroeconomic aggregates like GDP and Investment. We consider GDP and Investment because the two hypotheses that we are examining have strong implications for these two macroeconomic aggregates. In particular, changes in productivity directly affect the rates of return and in turn affect investment. Similarly, a decrease in taxes increases the after tax return thus directly affecting investment.

3.3.1 Changes in the production technology of food away from home

Technological advancements in the production of food prepared away from home that result in lower prices are the most common explanation for the observed trends in consumption of food prepared away from home, food at home, and cooking times. We use our model to derive the quantitative implications of this hypothesis.

We capture technological improvements in the food away from home sector by introducing a sequence of productivity parameters, A_F , that grows faster than the general growth rate of total factor productivity during our sample period.¹⁰ An increase in the productivity of the food prepared away from home sector increases its supply, which results in a lower price. Lower prices for foods prepared away from home cause households to consume more of these goods and, via a substitution effect, less meals prepared at home from scratch. The latter implies lower cooking times and grocery expenditure. Table 5 below reports the quantitative implications of three possible values for the productivity of the food away from home sector as suggested by Cutler, Glaeser and Shapiro (2003).¹¹ The first sets A_F in 2004 so as to match the observed change in aggregate cooking hours, the second matches the observed change in expenditure in groceries, finally, we consider a value for $A_{F,2004}$ so that the model matches the observed changes in expenditure in food away from home.¹²

¹⁰Data on the capital stock, hours worked, and value added for the food away from home sector is available in the U.S. NIPA from 1987 to the present. A measure for A_F based on such data, and on the corresponding production function of our model, shows productivity in this sector growing slightly below 2% per year. Measured output in the food away from home sector is subject to biases from changes in portion size and quality. Thus, we have chosen to set the values of A_F based on existing hypotheses and to explore its quantitative implications.

¹¹It has been suggested by these authors that changes in technology are behind the observed increase in expenditure of foods prepared away from home, behind the decline in cooking times, and also behind the drop in meals prepared at home from scratch.

¹²We compute the aggregate economy as the weighted sum of the total expenditures for each type of household in the

We report first the implications of the model for aggregate expenditures and calorie consumption.

Aggregates	$\Delta\%$ Data	$\Delta\%$ Model Target L_h	$\Delta\%$ Model Target I	$\Delta\%$ Model Target P_{FF}
$\frac{A_F}{A_m}$		1.07	1.10	1.40
GDP	13%	-1%	-2%	-3%
Investment	38%	-2%	-3%	-7%
Exp. Non Food	19%	5%	5%	9%
Exp. Groceries	-40%	-35%	-40%	-84%
Exp. Food Away from Home	41%	10%	12%	41%
Calories consumed				
From Groceries	-4%	15%	-4%	-71%
From Food Away from Home	67%	30%	32%	67%

Table 5: Data and model implications for different values of A_F . Per-capita expenditures are relative to a 2% trend.

The increase in output that results from higher productivity in the food away from home sector may not compensate for the decline in its relative price and GDP may fall. This is exactly what happens in our benchmark experiment where GDP declines by at least 1%, and investment by at least 3% relative to a 2% trend. These two predictions are not consistent with U.S. data where per capita GDP increased by 13%, and investment by 38% relative to a 2% trend. In all of the experiments we consider, changes in technology fall short of accounting for the observed increase in aggregate expenditure on non-food consumption items. An increase in technology that makes the model match the observed drop in aggregate cooking times delivers very similar implications for consumption expenditures to the experiment where change in groceries is the target. This occurs because of the high complementarity between groceries and cooking times. In both cases, however, the model is only capable of accounting for about one-fourth of the increase in expenditure in food prepared away from home. Productivity in the food away from home sector can be set so that the model matches the U.S. trends in expenditure on food away from home, but these results in a decline in grocery expenditure twice as big as what is observed in the data.

In order to obtain the implications of the model regarding calorie consumption we perform the following procedure. First, we derive from the U.S. data a transformation factor mapping dollars spent into calories consumed for each type of food. This transformation factor is such that the observed change in real per capita expenditures is compatible with the observed change in calorie consumption from the data. Finally, we apply the same transformation factor to the expenditures obtained in the model and derive the calories consumed implied by the theory. Using this procedure, Table 5 shows that technological advancements in the production of foods prepared away from home when we target

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 is married, 15% are single females and 7% are single males.

aggregate hours predict more than half of the caloric increase due to food away from home and is qualitatively inconsistent with the observed decrease in calories from home cooked meals. When the target is expenditures on ingredients the model can only account for half of the calories of food away from home and by construction all of the caloric decrease in home cooked meals. Finally, when the target are the expenditures of food away from home, the model over states the decrease in calories from home cooked meals by almost a factor of two, and by construction matches all of the caloric increase from food away from home.

Table 6 below documents the implications of the model for time use under the three different parameter values chosen for A_F .

	Δ % Data	Δ % Model	Δ % Model	Δ % Model
Households		Target L_h	Target I	Target P_{FF}
Married couples				
Work (female)	108%	14%	15%	28%
Work (male)	-1%	-8%	-8%	-15%
Food prep. (female)	-50%	-44%	-48%	-86%
Food prep. (male)	35%	-44%	-48%	-86%
Single females				
Work	10%	5%	6%	12%
Food prep.	-46%	-23%	-30%	-66%
Single males				
Work	0%	2%	3%	7%
Food prep.	0%	-25%	-30%	-71%

Table 6: Data and model implications for time use.

The model is capable of matching the qualitative patterns of time use in the U.S., except for the time devoted to food preparation and cleaning of married males. As previously discussed, lower food prices make households demand less food prepared at home. Thus, households demand fewer groceries and lower their cooking times. Time formerly devoted to cooking is optimally allocated between leisure and an increase in market hours, which allow households to increase their incomes.

Quantitatively, changes in technology can account for the decline in cooking times of married females, and for two thirds of the decline in cooking times of single females. The model, however, falls very short of explaining the increase in market hours of married females (which is the most important change observed in the data), and predicts strong declines in market hours and cooking times of single and married males not present in the data.

In summary, the model cannot jointly account for the changes in expenditure in food away from home, groceries, non-food consumption items, and key macroeconomic aggregates.

3.3.2 Changes in income taxes and gender wage gap

We now evaluate the hypothesis that lower income taxes and gender wage gap alone have translated into higher opportunity cost of cooking at home, which caused households to substitute home made meals for foods prepared away from home. In particular, we assume the 1955-65 period 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. Table 7 reports the data together with the quantitative implications from the model for aggregate food expenditures, the relative price of food away from home, and caloric consumption. The column labeled taxes and τ_d in Table 7 considers the joint implications of the observed changes in taxes and in the gender wage gap. To separate the role of taxes from the gender wage gap, the column labeled only taxes reports the predictions from the model when taxes change as in the data keeping the gender wage gap at its 1960s level (i.e. $\tau_d=0.43$).

Aggregates	$\Delta\%$ Data	$\Delta\%$ Model taxes and τ_d	$\Delta\%$ Model only taxes
GDP	13%	17%	11%
Investment	38%	40%	34%
Exp. Non Food	19%	24%	9%
Exp. Groceries	-40%	-37%	8%
Exp. Food Away from Home	41%	32%	8%
Calories consumed			
From Groceries	-4%	0%	72%
From Food Away from Home	67%	56%	10%

Table 7: Data and model implications for food expenditures and calorie consumption. Per-capita expenditures are relative to a 2% trend.

The predictions of the model with respect to, GDP, investment, expenditure of non food, the expenditure of food away from home, and expenditures in groceries are qualitatively consistent at the aggregate level. With respect to its quantitative implications, the model slightly over predicts the increase in expenditures of non food, GDP and investment. The model can account for 93% of the observed changes in groceries. The joint trends of taxes and gender wage gap can also account for 78% of the actual increases in expenditure in food away from home.

As we can see from Table 7, changes in taxes alone has predictions of the model with respect to GDP, investment, expenditures of non food, and food away from home that are qualitatively consistent at the aggregate level. Quantitatively speaking, just taxes can only account for a fifth of the increase in expenditures of food away from home. Lower taxes have a positive income effect and expenditures in all goods, including groceries, go up. Thus, the fact that women, both married and single, face different opportunity costs than men have important consequences on the food choices that households make.

With respect to increased calorie consumption, changes in taxes and the gender wage gap are qualitatively consistent with the decrease in calories from ingredients and can explain almost all of the caloric increase resulting from food away from home. This finding emphasizes the importance of the gender wage gap in accounting the observed number of calories.

Based on the previous results, we conclude that the increased opportunity cost of cooking at home is important in accounting the food expenditures and calorie consumption of the representative American household. Both of the two channels (changes in tax rates and in the gender gap) studied in this paper, which drive the increased opportunity cost of time, seem to be quantitatively and qualitatively relevant.

Table 8 reports the data and the model’s implications for time use for the case where taxes and the gender gap are changed as in the data and for the case where only taxes are changed.

Households	$\Delta\%$ Data	$\Delta\%$ Model	$\Delta\%$ Model
		taxes and τ_d	only taxes
Married couples			
Hours worked (female)	108%	107%	2%
Hours worked (male)	-1%	-19%	2%
Hours food prep. (female)	-50%	-46%	8%
Hours food prep. (male)	35%	-28%	8%
Single females			
Hours worked	10%	19%	-3%
Hours food prep.	-46%	-3%	9%
Single males			
Hours worked	0%	11%	-3%
Hours food prep.	0%	-4%	12%

Table 8: Data and model implications for time use.

Changes in tax rates and in the gender gap seems to match the qualitative patterns of time use in the U.S. except for the time devoted to food preparation and cleaning of males, which is small in absolute terms anyway. Quantitatively, the model does a good job in predicting changes in time use of married females. However, it predicts a large decline in hours worked of married males that is not present in the data. In our model, the distribution of resources within married households is determined by maximization of a weighted utility. The failure of this type of models in accounting fully for the observed trends in hours worked as the gender wage gap drops has been studied recently by Knowles (2007). This author develops a theory where the distribution of resources within married households is determined in a bargaining game. Such a model results in a much better fit for the time use of husbands and wives as a result of changes in the gender wage gap. We do not expect the total demand of goods of the married household to change much under such bargaining specification. Thus, to keep our presentation simple, we decided to abstract from bargaining issues in our analysis.

The transmission mechanism of our model, relating increased opportunity cost of time to food choices, implies that single males should be the group least affected by changes in taxes and the gender wage gap. Notice, however, that lower taxes and gender gap have an important general equilibrium effect on income. Thus, our theory is consistent with a modest increase in food consumption, caloric intake, and BMI for single males as a result of their higher income.¹³ Similarly, partnership households, and particularly married females should be the group with the highest increase in BMI. The previous implications of our model are consistent with BMI data by marital status and gender reported by Cutler, Glaeser and Shapiro (2003).¹⁴

We can conclude then that lower taxes and the narrowing of the gender wage gap between male and female workers are important elements when accounting for the increased calorie consumption over the last 40 years in the U.S. 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.

3.3.3 Further discussion

American households have substituted food prepared from scratch at home for food prepared away from home. Moreover, according to dietary studies people end up consuming more calories when eating food prepared away from home. An interesting question is why, in equilibrium, food prepared away from home has not become more similar to food prepared at home from scratch. Certain observations suggest that changes in technology in the food away from home sector have favored the production of calorie-intensive foods relative to healthier foods (or at least higher prices for foods prepared away from home that are also healthier). First, technical change in the preparation of mass produced foods has contributed to widen the gap between the price of healthier foods and calorie dense foods over time.¹⁵ The widespread use of hydrogenated oils constitutes one of the examples of technological advancements that favored high calorie food.¹⁶ The greater the degree of hydrogenation, the more saturated the fat becomes. Benefits of hydrogenating plant-based fats for food manufacturers include an increased product shelf life and decreased refrigeration requirement. Plant-based hydrogenated vegetable oils are much less expensive than the animal fats traditionally favored by bakers, such as butter or lard, and may be more readily available than semi-solid plant fats such as palm oil. Finally, partially hydrogenated oils spoil and break down less easily under conditions of high temperature heating. This is why they are used in restaurants for deep frying, to reduce how often the oil must be changed.

¹³Higher income is translated in higher food consumption thus more calories.

¹⁴The BMI of single men increased among adults (4.5 percentage points, as opposed to that of married men which increased by 6.22 percentage points) during our sample period. Married females constituted the group with the largest increase in BMI equal to 12 percentage points during our sample period.

¹⁵A typical example is the dramatic increase in the production of trans fats since the 1960s.

¹⁶“Hydrogenate” means to add hydrogen or, in the case of fatty acids, to saturate. The process changes liquid oil, naturally high in unsaturated fatty acids, to a more solid and more saturated form.

It is beyond the scope of the present paper to consider additional heterogeneity within each household, although it would be an interesting exercise. Available evidence suggests that an extended version of the current model with heterogeneous agents within each household would have the potential to explain some other features of the data for various subgroups of the U.S. population. The data is particularly suggestive for the hypothesis that explains higher weights through changes in the opportunity cost of time. 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 levels (see Table 9).¹⁷

	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 9: Obesity rates among U.S. adults by gender and education level, taken from Zhang and Wang (2004).

Thus, if higher education is correlated with higher opportunity cost of time, then groups that have increased obesity the most have been the groups that have seen their opportunity cost increased the most too. Furthermore, one of the main factors causing the increased weight of American adults suggested by 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 less than that 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 consistent with the hypothesis that the increased opportunity cost of cooking at home is an important factor driving the increase in obesity in the U.S. over the last forty years.

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

¹⁷The 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.

Finally, at the international level, Foreman-Peck, Humphries, Morris, Offer and Stead (1998) find that increased obesity rates in Great Britain are correlated with the lowering of the gender gap and substantial reduction in taxes. The British experience parallels that of the U.S. emphasizing the importance of the increased opportunity cost of cooking at home when studying increased obesity rates.

A puzzling observation that emerges from Table 9 is that, at the cross-sectional level, the groups of people with higher education, income, and thus higher opportunity cost of time, are less likely to be obese at a given point in time. It seems then important to discuss how this observation can be reconciled with the transmission mechanism linking higher opportunity cost of time to higher consumption of food prepared away from home, and to higher consumption of calories. The evidence in Andrieu, Darmon, and Drewnowski (2006) as well as in Drewnowski and Darmon (2005) illustrate that, at a given point in time, the price of foods with higher fat and calorie content is cheaper than that of foods with lower calorie content and higher nutritional value. Thus, if low nutritional value/high calorie foods are inferior while high quality foods are normal goods, then people with high opportunity costs of time (and thus higher income) should be less likely to be obese at a given point in time.¹⁸ Notice, however, that people with the highest opportunity cost of time have gained the most weight over time. The latter fact suggests that the lower price of high calorie food brought by technological change in the mass preparation of foods has dominated the income effect in determining the caloric composition of food away from home consumed by American household.

4 Conclusions

The steepness in the rate of weight increase of the average American adult during the last 40 years seems to be puzzling. 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, such as increasing the chances of suffering cancer, heart disease, and diabetes. Understanding the underlying causes of the rapid increase in obesity rates over the last forty years is paramount to the debate over policies meant to reverse it.

Our analysis suggests that the observed increase in the average weight of American adults is not puzzling but, rather, a natural consequence of changes in the opportunity cost of time. In particular, we have found that the observed trends in taxes and the lowering of the gender wage gap alone have increased the opportunity cost of time, which has resulted in dramatic changes in the time use and food composition chosen by the average household. The time households wish to spend in home production activities, including cooking, has substantially decreased. Instead of cooking at home, households have responded to lower taxes and the lowering of the gender wage gap by choosing to eat more foods prepared away from home. The latter resulted in higher caloric intake for the average American household. Thus, changes in taxes and in the gender wage gap must be part of any successful

¹⁸A possible example of inferiority of certain foods would be to consider fast food restaurants versus sit in restaurants, canned fruits and vegetables versus fresh fruits and vegetables or spam versus prime steak.

explanation of the raise in obesity in the U.S.

When taxes and the gender wage gap are held constant, technological advancements in the food away from home sector can make the model match either the observed drop in aggregate cooking times, or the higher expenditure in food away from home, or the observed decline in expenditures on groceries. What the model cannot do is to account jointly for expenditure trends in food items and cooking times. Moreover, this hypothesis also implies counterfactual declines in GDP and investment.

Finally, more disaggregated panel data shows a positive correlation between changes in opportunity cost of time and weight gains, which is consistent with one of the transmission mechanisms examined in this paper. Similarly, evidence from the nutrition literature suggests that the price of foods with higher fat and calorie content is cheaper than that of foods with lower calorie content and higher nutritional value. Thus, if low nutritional value/high calorie foods are inferior while high quality foods are normal, then people with high opportunity costs of time (and thus higher income) should be less likely to be obese at a given point in time, but more likely to gain weight as a result of changes in the opportunity cost of time. To capture these mechanisms requires generalizing the model to include further heterogeneity within households, and different alternatives when eating away from home; i.e., fast food versus sit in restaurants, a subject for further research.

Data 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.
- To compute the data corresponding to the relative price of food relative to the GDP deflator, 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.
- To compute the total caloric intake for each type of food, 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) in Figure 2, which reports the fraction of calories due to food away from home and to home meals.

- **Computation of income tax rates:** Existence of a balanced growth path where all households hold a positive stock of capital in this model requires a common capital tax rate for capital income across households. We, nevertheless, want to capture a basic feature of the data: Wage income is taxed at different rates for different households. The statistics of income report income sources and taxes paid by marital status, but it does not decompose single households by gender. The statistics of income do not divide married households into two wage earners or one wage earner either. Gender and female labor participation are key features of our model. Hence, we had to approximate incomes and marginal tax rates.

To obtain the tax rate on marginal income by gender and marital status we proceed as follows. First, we derive an average hourly wage. Then, using the information on hours worked by marital status and gender we compute total labor income for each type of household. Finally, from the statistics of income we can compute the total taxable income that corresponds, on average, to each different level of labor income, as well as the associated tax bracket. The details involved in each one of these steps follow.

We start by deriving the composition of households. From the Statistics of Income Individual Income Tax Returns, Table R, we determine household composition according to marital status. The U.S. Census Bureau IDB Data Access, Table 0.47, allows us to split single households into single males and females. The data reported by Bar and Leukhina (2005) helps us split married households into two wage earners and one wage earners. To derive the average hourly wage, we use Table 13 and Table 4 part 2 of the Individual Income Tax Returns and determine the fraction of total income due to salaries and wages. From this, we compute the average salary per person. We also compute 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. Hence, we can approximate total labor compensation by gender, marital status, and female labor participation status in married households. Finally, from Table 4, part 2, we compute the ratio labor compensation income to taxable income, and extrapolate from this the taxable income for each type of household. Finally, we obtain the marginal tax rates by examining the tax brackets that correspond to each taxable income for each type of household. In this computation we take into account the fact that for one-wage-earner married households, the relevant marginal tax rate corresponds to switching from one worker to two.

Tax rates on profits are taken from McGrattan and Prescott (2005). Finally, the tax rate on individual's capital income is computed as the weighted average of the different marginal income tax rates by gender and marital status.

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