Beyond the sticker price: including and excluding time in comparing food prices

Yanliang Yang,1* George C Davis,2 and Mary K Muth3

1Department of Agriculture and Applied Economics, College of Agriculture and Life Science, Virginia Tech, Blacksburg, VA; and 2RTI International, Research Triangle Park, NC

ABSTRACT

Background: An ongoing debate in the literature is how to measure the price of food. Most analyses have not considered the value of time in measuring the price of food. Whether or not the value of time is included in measuring the price of a food may have important implications for classifying foods based on their relative cost.

Objective: The purpose of this article is to compare prices that exclude time (time-exclusive price) with prices that include time (time-inclusive price) for 2 types of home foods: home foods using basic ingredients (home recipes) vs. home foods using more processed ingredients (processed recipes). The time-inclusive and time-exclusive prices are compared to determine whether the time-exclusive prices in isolation may mislead in drawing inferences regarding the relative prices of foods.

Design: We calculated the time-exclusive price and time-inclusive price of 100 home recipes and 143 processed recipes and then categorized them into 5 standard food groups: grains, proteins, vegetables, fruit, and dairy. We then examined the relation between the time-exclusive prices and the time-inclusive prices and dietary recommendations.

Results: For any food group, the processed food time-inclusive price was always less than the home recipe time-inclusive price, even if the processed food’s time-exclusive price was more expensive. Time-inclusive prices for home recipes were especially higher for the more time-intensive food groups, such as grains, vegetables, and fruit, which are generally underconsumed relative to the guidelines.

Conclusion: Focusing only on the sticker price of a food and ignoring the time cost may lead to different conclusions about relative prices and policy recommendations than when the time cost is included.

Keywords: food group recommendations, time-exclusive price, time-inclusive price, food price, preparation time

INTRODUCTION

It is well known that consumers generally underconsume fruit, vegetables, dairy, and whole grains but consume about the right amount of proteins (1). Food choices are influenced by many factors (2), but the importance of the price of food has received a great deal of attention in the literature. Numerous studies calculate and compare the prices of different foods (3–18). Some claim that foods with lower energy densities per weight, such as fruit and vegetables, are more expensive than foods with higher energy densities per weight (3–9), whereas others claim this is not the case (10–17). In their meta-analysis of 27 studies, Rao and colleagues (18) found that price differences were much greater when prices were based on kilocalories as opposed to other units such as serving size. The core of this debate has centered on the appropriate units for measuring the direct price the consumer pays at the store. However, the value of time is another dimension in measuring price that has not received much attention and could be just as important for many consumers.

The term “price” in economics has a broader meaning than just the direct monetary cost of a good, and the direct monetary price alone is unlikely to comprehensively capture the economic factors that determine consumers’ choice. Indeed, when consumers are asked about barriers to healthy food choices, money and convenience often rank high in importance (2, 19–21). Money is considered the direct out-of-pocket cost, but convenience implicitly has a time component as well, where the time cost can be viewed as labor cost. Research supports this broader view by showing that time, not money, is the main factor in preventing individuals from meeting the Supplemental Nutrition Assistance Program nutritional targets in aggregate (22, 23), and a Institute of Medicine report on the adequacy of Supplemental Nutrition Assistance Program benefits calls for investigating ways to incorporate time constraints into the benefit calculations (24). Consequently, focusing solely on the time-exclusive price (i.e., the direct price) of food could give a distorted view of a broader time-inclusive price.

Time can be a substantial constraint affecting food choices for many individuals. Nobel Prize winner Gary Becker stated that “in the United States, the opportunity cost of time may be more important than the direct [money] cost of goods” (p. 47) (25). In Becker’s 1965 seminal work, he demonstrated how time and money constraints can be combined, leading to what is called the “full price” of a good (26). Becker’s full price of a good includes both the direct cost and the time cost. Estimating the

1The authors reported no funding received for this study.
*To whom correspondence should be addressed. E-mail: ylyang@vt.edu.
Received October 17, 2014. Accepted for publication April 21, 2015.


Copyright (C) 2015 by the American Society for Nutrition
full price of a good is now standard in economics, especially labor economics. The economic and policy implications of analysis based on full price can be quite different from those based on the direct price alone. Becker’s full price concept has a very precise meaning in his article as referring to the opportunity cost associated with the individual’s main personal resources, money and time. However, it is recognized that the term full price may carry for many an even broader connotation that is not consistent with Becker’s definition or as used by economists. To avoid this equivocation, in this article, the term “time-inclusive price” is used for Becker’s full price concept, and the term “time-exclusive price” is used for the direct price of a good.

The purpose of this article is to compare prices that exclude time (time-exclusive price) with prices that include time (time-inclusive price) for 2 types of home foods: home foods using basic ingredients (home recipes) vs. home foods using more processed ingredients (processed recipes). The terms “basic” and “processed” as used here refer to differences in ingredients with respect to preparation time. For example, suppose one has a broccoli salad recipe. A basic recipe would be preparation of the salad from basic ingredients and including washing and chopping the broccoli stalks. Alternatively, a processed recipe would be a ready-to-eat broccoli salad or a salad mix that requires only that the consumer open the package and mix the ingredients. The key idea associated with the term “processed recipe” is labor saving, which contains a certain degree of processing but not done by the consumer. It does not refer to the number of additives or preservatives in the food item, which may be present in some but not all processed foods. This study sought to compare prices both inclusive and exclusive of preparation time to assess how the consideration of time affects conclusions about relative costs of foods.

METHODS

Becker’s full price, what we are calling time-inclusive price, is described elsewhere (22, 27), so only the final formula is given here:

$$FP_i = p_i + t_i \times w$$  \hspace{1cm} (I)

In this formula, \(p_i\) is the direct time-exclusive price and \(t_i\) is the amount of time associated with the \(i\)th food. Time could be preparation time if the food is prepared at home, or if one is eating out, it could be the amount of time waiting, but more generally, it is the relevant time directly associated with production or acquisition of the food. The variable \(w\) is the dollar value placed on a unit of time. One can think of \(w\) as how much the consumer would be willing to pay someone to do it for him or her per unit of time in this activity.

As a point of clarity and precision, it is important to recognize that the economic approach makes a sharp distinction between costs and benefits. At the individual level, costs are defined as those associated with the allocation of personal resources: how much of your monetary and time resources do you give up for the food? Becker’s full price concept has a very precise meaning in his article as referring to the opportunity cost associated with the individual’s main personal resources, money and time. However, it is recognized that the term full price may carry for many an even broader connotation that is not consistent with Becker’s definition or as used by economists. To avoid this equivocation, in this article, the term “time-inclusive price” is used for Becker’s full price concept, and the term “time-exclusive price” is used for the direct price of a good.

The purpose of this article is to compare prices that exclude time (time-exclusive price) with prices that include time (time-inclusive price) for 2 types of home foods: home foods using basic ingredients (home recipes) vs. home foods using more processed ingredients (processed recipes). The terms “basic” and “processed” as used here refer to differences in ingredients with respect to preparation time. For example, suppose one has a broccoli salad recipe. A basic recipe would be preparation of the salad from basic ingredients and including washing and chopping the broccoli stalks. Alternatively, a processed recipe would be a ready-to-eat broccoli salad or a salad mix that requires only that the consumer open the package and mix the ingredients. The key idea associated with the term “processed recipe” is labor saving, which contains a certain degree of processing but not done by the consumer. It does not refer to the number of additives or preservatives in the food item, which may be present in some but not all processed foods. This study sought to compare prices both inclusive and exclusive of preparation time to assess how the consideration of time affects conclusions about relative costs of foods.

METHODS

Becker’s full price, what we are calling time-inclusive price, is described elsewhere (22, 27), so only the final formula is given here:

$$FP_i = p_i + t_i \times w$$  \hspace{1cm} (I)

In this formula, \(p_i\) is the direct time-exclusive price and \(t_i\) is the amount of time associated with the \(i\)th food. Time could be preparation time if the food is prepared at home, or if one is eating out, it could be the amount of time waiting, but more generally, it is the relevant time directly associated with production or acquisition of the food. The variable \(w\) is the dollar value placed on a unit of time. One can think of \(w\) as how much the consumer would be willing to pay someone to do it for him or her per unit of time in this activity.

As a point of clarity and precision, it is important to recognize that the economic approach makes a sharp distinction between costs and benefits. At the individual level, costs are defined as those associated with the allocation of personal resources: how much of your monetary and time resources do you give up in making a choice? Alternatively, benefits refer to the overall satisfaction (utility in the economist lexicon) the individual gets from the purchase or decision. In the economic approach, the individual makes a decision based on considering the net benefits of the decision that are important to him or her: all benefits (e.g., taste, social, cultural) less all personal resource costs (e.g., money, time). Of course, with any choice, there can be benefits associated with the choice that have nothing to do with the individual’s resources (e.g., the taste, a coolness factor, culturally acceptable, or environmentally sustainable). A negative impact on the environment of a choice may be a “cost” in laymen terms but is not technically considered a cost in the economic framework of individual choice. In the economic framework, it is a negative benefit or, more precisely, a disutility referred to as a negative externality. Within this framework, the Becker full price is simply providing a fuller resource-based cost accounting that includes time cost. This does not mean that other factors do not come into play, such as taste, culture, or the environment, only that a higher time cost is an unaccounted for disincentive (not an ultimate determinant) when considering the purchase of a food item. In this context, the time-inclusive price is just a generalization of the direct price of a good, which of course is not the only determinant of food choice.

In this study, the time-inclusive price (Becker’s full price) was calculated as the sum of the direct (time-exclusive) price \(p_i\) and value of time in the food item, \(t_i \times w\). The time-exclusive price \(p_i\) was calculated as the total cost paid for all ingredients used in a recipe, which is described in more detail in Results. For the time component of a recipe \(t_i\), only hands-on preparation time (e.g., washing, chopping, and mashing) was considered in the analysis because it was assumed during cooking time (e.g., baking lasagna in an oven) or other preparation time (e.g., soaking dried beans) that the food preparer could be engaged in other activities. To estimate the value of time \(w\), we used the standard market substitute approach from labor economics that has been used elsewhere (22, 23), which values time in the household at the amount the input (labor) could be purchased on the market. Hourly wage information was obtained from the Bureau of Labor Statistics for the Food Preparation and Serving-Related Occupations category (occupation code 35-0000) (28). There are 24 categories of suboccupations in this category. Descriptive analysis of this major group shows a wage distribution with a median of $9.15 and range of $6.96 between the 10th percentile and the 90th percentile. Because of the uncertainty on the appropriate value of time to use, we followed the approach of Davis and You (23) to conduct a sensitivity analysis. Specifically, based on the reported wage distribution information, we determined that a normal wage distribution with a median of 9.15 and an SD of 3.5 would match the data given by the Bureau of Labor Statistics. We then drew 1000 wage observations from this wage distribution and calculated the value of the time-inclusive price from the equation 1000 times and then reported the mean and 95% CI from the empirical distribution of the time-inclusive price. The calculations are based on per serving size but also on the MyPlate recommendations for daily servings. MyPlate, formerly MyPyramid, is the current nutrition guide published by USDA. For a 2000-calorie diet, the daily intake should be 6 servings of grains, 5.5 servings of protein, 5 servings of vegetables, 4 servings of fruit, and 3 servings of dairy (29).

Description of data

Simply comparing the direct time-exclusive price of different foods does not require knowledge of how foods are used and is
therefore relatively easy to do. A major difference in estimating the time-inclusive price of a food is that how the food is used must be considered as well; this is a consideration the consumer takes into account that is missing in a time-exclusive analysis. Consequently, in calculating the time-inclusive price of a food, the relevant level of analysis must be at the “recipe” level, defined very broadly as how the food might be used.

In an ideal setting, there would be a national database of many recipes indicating the direct cost and time associated with each recipe, but such a data set does not exist. In this analysis, we used the recipe database created by the North American Branch of the International Life Science Institute for the web-based application called Food Value Analysis (30). This application was initially created to help consumers see not only the direct cost of foods but also the time associated with producing foods. However, the database also allows for analysis in comparing time-exclusive and time-inclusive prices of selected foods. In Table 1, a brief overview of the data is given. A more comprehensive discussion can be found in Muth et al. (31).

The foods were selected to represent a range of commonly consumed entrées, entrée components, fruit, vegetables, grains and starches, baked goods, desserts, condiments, and beverages. One hundred recipes were selected from the USDA Food and Nutrition Database for Dietary Studies (FNDDS*: version 5) (32) or the USDA National Nutrient Database for Standard References (SR: version 24) (33). These recipes are called home recipes because they are prepared from basic ingredients with most of the cooking process done at home. In some instances, a combination of FNDDS and SR data was used to create a home-recipe form of the food because it was not available within a single code (e.g., garlic bread, meatloaf with mashed potatoes and vegetables, and cheese pizza). The recipes for all foods are available by selecting and viewing foods on www.foodvalueanalysis.org (30). It should be pointed out that the term recipe is being used in its most general form and includes any final consumption food consisting of one or more food ingredients. So there is a “recipe” for apple slices or fresh strawberries, but these require only one ingredient. Of course, other recipes will have more than one ingredient (e.g., lasagna).

In addition to the 100 home recipes, 143 “processed recipes” were chosen to match the 100 home recipes. The processed recipes reflect different points on the continuum of the processing scale from partially processed (canned or frozen ingredient substitutions) to entirely prepared foods (ready-to-serve food). The processed forms of foods were selected from the FNDDS, SR, and Gladson Nutrition Database (GND) (34), and as many as 3 processed forms (e.g., refrigerated, frozen, dry-mix pie crust) were included based on the available data to pair with the unprocessed home recipe; this is why there are 143, not 100, processed recipes.

The data set from the North American Branch of the International Life Science Institute contains estimated price and preparation time for each recipe. Both direct price and preparation time were calculated on a per-serving basis, with serving size determined according to FNDDS or the Reference Amounts Customarily Consumed (35).

Food prices were obtained from the USDA Center for Nutrition Policy and Promotion Food Prices Database, 2003–2004 (36, 37), if available for the FNDDS code, which accounts for moisture losses and gains and refuse losses in preparing recipes from multiple ingredients. If food prices were not available in the Food Prices Database, national average prices were calculating by using The Nielsen Company’s Homescan database for 2010 (38) by applying calculations comparable to those for the Food Prices Database. All prices were adjusted to 2011 values by using the Bureau of Labor Statistics’ consumer price index for “food at home” (39).

Food preparation and cooking times for home recipes were obtained by using the Betty Crocker Cookbook, Better Homes and Gardens New Cookbook, and FoodNetwork.com’s “Recipes and Cooking” (40–42). For foods prepared from packaged foods, preparation and cooking times were obtained from package instructions (e.g., 7 min for heating a frozen meal or 4 min for heating a canned entrée). If preparation involved opening a package and putting the food in a microwave, preparation time is shown as “minimal” in the application and assumed to be zero in our calculations. The few foods without published preparation and cooking times were prepared to measure times in a test kitchen by a North Carolina State University extension specialist after procedures used by typical consumers. In addition to preparation and cooking time, consumers must clean up cooking surfaces and utensils. We did not include cleanup time because estimates were not available from existing sources.

Given the interest in the implications the analysis will have for dietary recommendations, the recipes were categorized according to their appropriate food group by using either the FNDDS or GND codes (32, 34). Sixty-seven percent of the foods were in the FNDDS database with the corresponding food group code. Twenty-six percent of the remaining foods were in the USDA SR and 7% in the GND. These foods were then matched with comparable foods in the FNDDS database and categorized accordingly. Foods that could not be matched were placed into the residual category called “others.” For example, coffee with milk or hot chocolate was placed in the “others” category. In the analysis, we dropped the “others” group to focus on the main 5 food groups. We grouped these foods into the following: protein, fruit, vegetables, grains, dairy, and a residual other. A mixed-dish recipe, such as lasagna with meat, has the FNDDS code 58130011 and therefore was grouped into grains because in the FNDDS database, a code starting with 5 is considered grains.

RESULTS

The average direct time-exclusive price and preparation time for the 6 food groups for the home recipes and processed recipes per serving are given in Table 1. Most processed recipes are made from canned, frozen, or ready-to-serve ingredients, which have part or most of the preparation process done by manufacturers already, so intuition may suggest that the processed time-exclusive (direct) prices would be greater than the home time-exclusive prices (because of value-added processing). However, we found that the difference in the time-exclusive price per serving for home and processed recipes was statistically

---

4 Abbreviations used: FNDDS, Food and Nutrition Database for Dietary Studies; GND, Gladson Nutrition Database; SR, The USDA National Nutrient Database for Standard Reference.
significant only for the vegetable group. Over all groups (subtotal), the time-exclusive price was essentially the same for home and processed recipes, and the difference was not statistically significant. This insignificance suggests that offsetting cost efficiencies (e.g., large-scale production and specialization) associated with the production of value-added (time-saving) products allow them to be sold at a price comparable to less time-saving products.

The comparison of preparation time per serving revealed a much different story than the direct time-exclusive price. All home recipes for each food group showed a greater preparation time than for their corresponding processed forms, and all differences were statistically significant, except for the dairy and others group. Over all groups (subtotal), the preparation time for home recipes was 18 times greater on average than for processed recipes, and all differences between the home and processed were statistically significant. This insignificance suggests that offsetting cost efficiencies (e.g., large-scale production and specialization) associated with the production of value-added (time-saving) products allow them to be sold at a price comparable to less time-saving products.

Following Gronau and Hamermesh (43), the final column in Table 1 gives the calculated mean time-exclusive and time-inclusive prices. Note that the ratio for the time-inclusive price is preparation time divided by time-exclusive price. This pattern does not change even though the sensitivity analysis provides the 95% CI range accounting for the uncertainty related to the value of time. Most foods in the grain groups, such as biscuits and bread, are made from flour based on homemade recipes and require more time. For vegetables, the share of time cost is high because these foods require more time in cleaning, peeling, cutting, or mashing when the ingredients are raw and fresh. Thus, the time-exclusive price gives a distorted view of the broader time-inclusive price of the recipe.

In terms of the MyPlate recommended servings (29), Table 2 shows the calculated mean time-exclusive and time-inclusive price for the recommended numbers of servings per day (columns 3 and 6, respectively). These results show that 1) the processed recipes were always cheaper than the home recipes in terms of the time-inclusive price, and 2) the home recipes showed much greater differences between the time-inclusive and time-exclusive price than did the processed recipes. Because economic decisions are based on relative prices (44), Table 2 also shows the ratios of the processed to home prices for the time-exclusive prices (column 4) and the time-inclusive prices (column 7). Note that the ratio for the time-inclusive price was always less than that for the time-exclusive price (column 7 vs. column 4) in comparing processed with home recipes. If one focused only on relative time-exclusive (direct) prices, one would conclude that processed grains and proteins were more expensive than their home counterparts (1.24 and 1.12, respectively) and that processed vegetables, fruit, and dairy were less expensive.
DISCUSSION

The direct price of food, exclusive of the time component, is certainly an important cost to consider in choosing a food, but the time cost associated with a food may be just as important, if not more so, for some consumers. For the 243 recipes considered here, even when processed recipes are more expensive than home recipes when time is excluded, when time is included, the processed recipes are always cheaper relative to home recipes. Consequently, consideration of time-exclusive prices alone can give a misleading indication of the relative prices of foods and therefore can potentially lead to different policy implications from those that ignore the time dimension. For example, based solely on a time-exclusive price per serving, one could argue that fruit and vegetables need no special policy, such as a subsidy or purchase incentives, because they are already cheap. However, once the time-inclusive price is considered, this conclusion may no longer be correct. Because the time-inclusive price includes a direct money component and a time component, even if little can be done to reduce the time component, reducing the money component still decreases the time-inclusive price.

This study had limitations. There are thousands of recipes, and we have considered only 243. As more foods are added to the database, this analysis could be repeated to determine whether a broader set of foods changes the magnitude of the estimates. One of the major challenges in doing time-inclusive price analysis is that, like the consumer, the researcher must not simply know what foods are purchased but how the foods are going to be used, which requires more detailed data and a deeper level analysis than just looking at the direct prices of foods. Here we did not have good information on cleanup time and so did not include it in the analysis, although given a home recipe likely involves more preparation, it also likely has more cleanup. Intuition suggests that the general results found here would extend to a larger database of more recipes and that including cleanup time would tend to reinforce the results found here, but that is an empirical issue. In addition, how much the consumer is willing to pay for the time in food preparation (the cost of the time) has received no real research in the literature, and the market substitute approach has been used as an estimate. Although the sensitivity analysis used here allows for a range on this cost and the general results are not very sensitive to the range, research is needed to better understand how consumers value time in food production. The grouping of individual food items into food groups is always challenging, and one must be aware of the fallacy of composition: what is true of the total is not necessarily true of all its elements. For “mixed recipes” (e.g., lasagna), we used the food group classification scheme provided by either the FNDDS or GND codes (32, 34), but clearly some other classification rule may affect the results. Finally, as indicated earlier, food choices are complex and based on many factors (e.g., taste, cultural, environmental, costs) and are not determined solely by prices. In making a decision, the consumer implicitly, if not explicitly, weighs the benefits and costs associated with the purchase. This research is simply indicating that a fuller cost accounting that captures time may be more relevant for many consumers and hence researchers and policy makers than cost accounting that ignores the role of time.
In conclusion, there has been much discussion in the literature on how to measure the direct price of foods. Although that research is important, the term “price” in economics has a broader meaning, and the goal of this research was to demonstrate how incorporating the value of time when measuring price can provide additional insights that are not captured by considering a time-exclusive price. The direct price of a food in the store is a time-exclusive price that is a special case of the broader time-inclusive price presented here. With the caveat in mind that the results here are limited to 243 recipes, the processed food time-inclusive price was always less than the home recipe time-inclusive price, even if the processed food’s time-exclusive price was more expensive. Increasing the amount of time associated with a food might be a deterrent to the consumption of that food. Focusing only on the direct time-exclusive price of a food in isolation and ignoring the time component could result in different conclusions about relative food prices and therefore policy recommendations.

We thank Shawn Karns for assistance with the data used in the analysis and the North American Branch of the International Life Science Institute for granting permission to use the Food Value Analysis data set for the analysis. The authors’ responsibilities were as follows—YY and GCD designed the research; MKM provided the data set; YY conducted the analysis and had responsibility for the final content; YY, GCD, and MKM wrote the article; manuscript; and all authors: read and approved the final manuscript. The authors declared no potential conflict of interest related to this study.

REFERENCES

22. Davis GC, You W. Not enough money or not enough time to satisfy the Thrifty Food Plan? A cost difference approach for estimating a money-time threshold. Food Policy 2011;36:101–7.