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RESEARCH ARTICLE

What is online Supplemental Nutrition Assistance Program shopping worth? An implicit wage rate approach using meal-kit pricing and time-use data

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Abstract
In 2023 all Supplemental Nutrition Assistance Program (SNAP) participants were allowed to start grocery shopping online. This paper provides the first answer to the question: What is online shopping worth to the SNAP participant in dollars? Using meal-kit pricing and time-use data, an implicit wage rate and dollar value distribution are estimated for time saved in home food production from online grocery shopping. We report the 95th, 75th, 50th, 25th, and 5th percentile results. We simulate saving 50%, 75%, and 90% of grocery shopping time and estimate the savings per hour per meal. For example, if online shopping saved 75% of shopping time, the median saving per hour per meal would be $2.59. If a family of four made 15 to 30 meals a month, this corresponds to an implicit 5% to 11% increase in the benefits per month due to the time saved. The implicit wage rate provides simple and elegant economic insights into many aspects of food production and consumption not obtainable by just considering the money price.

Keywords: Implicit wage rate; meal-kit; online shopping; Supplemental Nutrition Assistance Program; value of time

JEL Codes: D13; H31; H53; J22

Introduction

Over the last decade, numerous publications have demonstrated that Supplemental Assistance Nutrition Program (SNAP) benefits are inadequate to meet their stated goal, even with the increases in October 2021 (e.g., Caswell and Yaktine 2013, Christensen and Bronchetti 2020, You, Davis, and Yang 2021, Ziliak 2016). However, political realities place a very low probability of directly increasing SNAP monetary benefits (e.g., Maher 2023, Nestle 2019, Romm 2023). To make SNAP more effective, one politically attractive alternative, which avoids the thorny ideological issue of increasing monetary benefits, is to allow SNAP recipients to grocery shop online.

After some initial piloting, on June 9, 2023, online shopping for SNAP participants was announced available in all 50 states and the District of Columbia (USDA/FNS 2023). Allowing SNAP participants to shop online is an obvious direction to pursue because ignoring time in food production has been one of the main criticisms of SNAP (e.g., Caswell and Yaktine 2013, You, Davis, and Yang 2021, Ziliak 2016). This policy helps address this oversight and indeed recent research suggests it even helps reduce food insufficiency (Jones, et al. 2023). But like many policies, the ultimate question arises: what is online shopping worth to the individual? The answer to this question will be extremely useful in policy analyses and debates. And it is a question economists should be able to answer. This paper provides the first known answer to this important question.

Like many constructs in science, time in home food production is conceptually obvious but empirically challenging as it is a nonmarket valuation problem. The two most common methods found in the literature are the opportunity cost and market substitute approaches. Each has advantages and disadvantages (e.g., Gronau 1986, Juster and Stafford 1991). Here we highlight the main points.

The opportunity cost approach uses an individual's wage rate to value their nonmarket time. Depending on the required skill for the activity and the individual's wage rate, this approach can either over or underestimate the value of a do-it-yourself activity. For example, using a brain surgeon's wage rate to value cleaning their own house likely overstates the value, given the brain surgeon's wage reflects highly specialized skills not needed to clean a house. The opposite could also occur (e.g., a janitorial worker doing electrical wiring in the home). Thus, the opportunity cost does not reflect the skill level in the home production activity. Furthermore, for those unemployed, wages have to be estimated, so model specification hurdles must be confronted.

Alternatively, the market substitute approach uses a market wage rate for the service under consideration resulting in a better alignment with the required skill for the activity. In addition, it is empirically simpler and circumvents any modeling challenges. Yet, like the opportunity cost approach, the market substitute approach does not reflect the skill of the individual *doing* the activity. In the SNAP literature, both the market substitute and opportunity cost approaches have been implemented and produced estimates in the $9 to $12 (Davis and You 2011; Yang, Davis, and You 2019) and the $13 to $20 (Davis and You 2010, Raschke 2012) per hour range, respectively.

An attractive but unexplored third alternative is the "value-added" or "implicit wage rate" approach (e.g., Deacon and Sonstelie 1985, Hill 1985). The implicit wage approach is based on household production theory (Becker 1965) and is just a quantification of two of Benjamin Franklin's best-known aphorisms: (1) "time is money" and (2) "a penny saved is a penny earned." The intuition is simple. Anytime we decide to do something ourselves at home (e.g. prepare our taxes, mow our lawn, prepare a meal, etc.) rather than buy the good on the market (e.g. hire an accountant, hiring a lawn service, buy a pre-prepared meal) we effectively compare the full cost of the two alternatives, which must include the value of our time. In comparing the cost of the market good with the cost of doing it ourselves, we conclude that some household activities are NOT worth hiring someone else to do (make a sandwich) and others are (doing your taxes). From basic labor economics, the decision depends on the individual's reservation wage and the implicit wage comparison. The wage is *implicit* because it refers to the amount of money *saved* per unit of time by **not** engaging in one activity and engaging in another. Consequently, the higher the implicit wage rate (i.e., more money saved by not buying the market good), the more likely you are to do the activity yourself. There are two key and attractive features of the implicit wage rate approach. One, the dollar amount saved must be expressed in dollars per hour or a unit of time in the specific activity. So, unlike the opportunity cost and market substitute approaches, the implicit wage rate includes the time or skill level required in the activity and can vary by different specific activities. Two, like the market substitute approach, it does not require the individual's market wage rate and thus is applicable to both the employed and unemployed.

As will be explained in more detail below, a natural candidate for using the implicit wage rate approach is meal-kit pricing and home food production time data to estimate the value of labor in home food production. There is a small literature on the meal-kit market. For example, Carman et al. (2021) found participants were willing to pay \$88.61 ± 47.47 for a meal-kit with three meals and four servings per meal. However, they did not estimate an implicit wage rate as is done here.

This study has two objectives. The main objective is to provide an answer to the motivating question of the dollar value of online grocery shopping. In the process of answering this question, the second objective is to demonstrate the advantages of the implicit wage rate approach in explaining several stylized facts in food choices that cannot be easily explained by other comparable measures. In achieving these objectives five questions are answered:

1. What is the dollar value-added in meal-kits compared to their ingredient costs?
2. What is the estimated implicit wage rate in meal production?
3. How does the implicit wage rate estimate compare to estimates from other approaches and does it alter any conclusions regarding SNAP benefit adequacy?
4. What does the implicit wage rate estimate imply about the value of time saved via online SNAP shopping?
5. What would the implicit wage rate formula imply about meal-kit purchases across the food preparation time, skill, age, income, and product distributions?

Our empirical approach has some commonalities with the recent economics literature on valuing the effect of time-saving technologies on Gross Domestic Product (GDP), such as E-commerce (NRC 2005, Dolfen et al. 2023). As is clear from that literature, valuing time-saving technologies requires unavoidable cost allocation assumptions because the natural units for time use (e.g., minutes or hours) are often associated with multiple activities. Because of the uncertainty surrounding allocation assumptions and the variation in home food production time across recipes and individuals, the precision of any point estimate will be misleading. Consequently, we generate a distribution of values using a parametric bootstrap approach. We report percentiles in the belief that any differences across individuals and assumptions would yield results within the empirical distribution, making the results robust to individual and assumption idiosyncrasies.

As a brief summary, the difference between the meal-kit costs and the ingredient costs (the meal-kit value-added) is about \$13 on average for our data. The median implicit wage rate estimate is \$15.59 per hour, which falls within the \$9 – \$20 range found by other methods. This provides further support that earlier SNAP benefit inadequacy conclusions are robust to this new method. Most importantly, if the online shopping policy saved 50% to 90% of shopping time, the amount saved per meal would be in the \$1.53 to \$3.28 range at the median. Depending on how many meals are prepared over a month, this can be a substantial savings for low-income households. Finally, we discuss, more generally, how the implicit wage provides an elegant explanation for why individuals with lower culinary skills, or are younger, buy more time-saving foods, individuals with higher incomes buy more commercial meal-kits, and individual households purchase a portfolio of foods across the pre-prepared distribution.

The following section gives the underlying theory for estimating the implicit wage, followed by the data section, results, and a discussion. Limitations and future directions are discussed in the conclusions.

Methods

Theoretical framework

Household production theory provides the theoretical foundations for the analysis (Becker 1965). The meal production function is *nested*, requiring five stages or 'intermediate commodities' be produced in route to the final consumable meal or 'downstream commodity': (1) recipe(s), (2) a grocery list, (3) grocery store travel, (4) ingredients (i.e., purchasing groceries/shopping), (5) the "mise en place" assembly of ingredients, and (6) the final consumable meal. A meal-kit is the "mis en place" 5th stage commodity, meaning the recipe ingredients have been 'put in place' so that final assembly and/or cooking can commence. Someone preparing the *exact* same recipe at home as the commercial meal-kit will always reach the equivalent mise en place commodity stage or "homemade meal-kit." Afterwards, if placed side by side, the commercial meal-kit and the equivalent homemade meal-kit would be functionally indistinguishable and perfect substitutes. Indeed, creating an equivalent "homemade meal-kit" is the underlying premise of the recently created SNAP Express online service by USDA (2024). To be clear, at this point, one should not confuse this production (supply) side with the consumption (demand) side. This is the production side. The implicit wage rate gets at the relative consumption decision.

The decision of which to choose is based on the logic of Deacon and Sonstelie (1985) and Hill (1985), which flows from the indifference full-price equilibrium condition for the commercial meal-kit and homemade meal-kit:

$$P_c + wT_c = P_h + wT_h. \tag{1}$$

P_c is the market price of the commercial meal-kit, T_c is the *individual's* time spent acquiring the commercial meal-kit, P_h is the market cost of all the ingredients in the meal-kit recipe as purchased by the individual, T_h the *individual's* total time spent replicating the commercial meal-kit at home, and w is the *implicit wage rate* for the time associated with the meal-kit, which based on (1) will be

$$w = \frac{(P_c - P_h)}{(T_h - T_c)}. \tag{2}$$

The numerator gives the difference between the commercial meal-kit price and the ingredient cost, which is the "value-added" or the value of all intermediate services between ingredients and the commercial meal-kit. The denominator is the time difference between the individual's time associated with making the homemade meal-kit and acquiring the commercial meal-kit, which converts the value added to an hourly rate. The implicit wage rate w is interpreted following standard implicit and reservation wage logic from labor economics (e.g., Krueger and Mueller 2016). The wage rate is 'implicit' because it is the dollar value per hour *saved* by not buying the commercial meal-kit and instead making the homemade meal-kit. If the individual's implicit wage rate w is greater than their reservation wage w_r, then it *pays* to produce the homemade meal-kit at home (i.e., $w > w_r$). Alternatively, if the individual's reservation wage rate is higher than the implicit wage rate (i.e., $w < w_r$), it does not pay to produce the homemade meal-kit. For example, if $P_c = \$15$, $P_h = \$5$, $T_h = 60$ minutes, and $T_c = 10$ minutes, the implicit hourly wage rate for producing the homemade meal-kit would be \$12. For those with a reservation wage less than \$12, it pays to produce the homemade meal-kit themselves as they are implicitly making \$12 per hour, whereas for those with a reservation wage rate greater than \$12, the commercial meal-kit would be preferred.

Data

Equation (2) requires data on four variables: commercial meal-kit prices (P_c), ingredient cost for each meal-kit (P_h), total time in making the homemade meal-kit (T_h), and time spent in getting a commercial meal-kit (T_c). This section explains each in turn along with summary statistics.

Commercial meal-kit prices (P_c)

We collected publicly available meal-kit price data on 60 meal kits online in 2021, from the top three meal-kit companies: Blue Apron, Home Chef, and Hello Fresh. These companies constituted about 90% of the market at the time of data collection. Twenty meal-kits were randomly selected from each company. Table 1 lists all the recipes by company. The meals are *dinner* type meals with a wide variety (e.g., meatballs, chicken tenders, burgers, tacos, pizza, steaks, quiche, and wraps). A family of 4 is the SNAP baseline, so the option of 3 meals per week with 4 servings per meal was chosen. No coupons or specials were invoked in the prices. Recorded was the 'total price' reported online, which included any shipping fee.

Ingredient costs (P_h)

Correspondingly, each commercial meal-kit provides a recipe with ingredients. For the 60 recipes, there were a total of 565 ingredients and 253 unique ingredients. The number of units of each ingredient for a recipe were recorded based on 4 servings to align with the SNAP baseline. Ingredient prices were collected online from Peapod using the zip code 20001 for Washington, D.C. The price of each ingredient was recorded and divided by the number of units in the package to obtain a unit price. If the units listed on the package were different from the units used in the recipes, they were converted (e.g., fluid ounces to teaspoons). For ingredient mixes unique to the meal kit company (e.g., spice mixes), the mix recipe, provided by the company, was consulted, and treated as a 'sub-recipe' and the same process described above used. The unit price of each ingredient was then multiplied by the number of units required and then summed over all ingredients for 4 servings per recipe.

Table 2 gives the summary statistics across the three companies for the 60 meal-kit prices. All numbers are in terms of 4 servings (one meal). Each company charged their own constant price for 3 meals regardless of the meals chosen (0.00 s.d.). The average meal-kit prices across all meals and companies is \$32.64. This is similar to what Carman, et al. (2023) estimate individuals are willing to pay for a meal with four servings: \$29.54 (= \$88.61/3) on average. The average ingredient cost across all meals and companies is \$19.34. Of most interest is the price difference (value-added) column. Home Chef has the

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Table 1. Meal kit names by company

Recipe#	Company	Recipe
1	Hello Fresh	Thai-Spiced Pork Meatballs
2	Hello Fresh	Mozzarella-Crusted Chicken
3	Hello Fresh	Teriyaki Chicken Tenders
4	Hello Fresh	“Little Ears” pasta
5	Hello Fresh	Winner Chicken Orzo Dinner
6	Hello Fresh	Spanish one-pan chicken
7	Hello Fresh	Balsamic Fig Sirloin
8	Hello Fresh	Hoisin Pork Burgers
9	Hello Fresh	Chicken Sausage Gemelli Bolognese
10	Hello Fresh	Mexican Chicken & Rice Bowl
11	Hello Fresh	Pineapple Poblano Beef Tacos
12	Hello Fresh	Za’atar Chicken and Couscous
13	Hello Fresh	Green Olive Pasta Puttanesca
14	Hello Fresh	One-Pan Chicken and Couscous Pilaf
15	Hello Fresh	Chicken Cutlets with Scallion Sriracha Pesto
16	Hello Fresh	Chorizo Burgers
17	Hello Fresh	Pancetta White Pizzas
18	Hello Fresh	Bangers and Mash
19	Hello Fresh	Crispy Chiptole Shrimp Tacos
20	Hello Fresh	Pizza Burgers
21	Blue Apron	Honey Teriyaki Salmon
22	Blue Apron	Harissa Turkey Meatballs and Tomato Sauce
23	Blue Apron	Fig-Balsamic Chicken
24	Blue Apron	Salmon and salsa verde
25	Blue Apron	Miso pork chops
26	Blue Apron	Italian meatloaf and cauliflower
27	Blue Apron	Baked tofu and creamy tomato curry
28	Blue Apron	Zesty pork chorizo tacos
29	Blue Apron	Prosciutto and spinach focaccia pizza
30	Blue Apron	Seared steaks and chive butter
31	Blue Apron	Spicy chicken stir-fry
32	Blue Apron	Mushroom mazemen
33	Blue Apron	Southern-spiced fish and buttermilk cornbread
34	Blue Apron	Smoked gouda burgers

(*Continued*)

Table 1. (*Continued*)

Recipe#	Company	Recipe
35	Blue Apron	Hot honey chicken
36	Blue Apron	One pot chocolate and chipotle beef chili
37	Blue Apron	Creamy pesto fettuccine
38	Blue Apron	Chicken and spicy chipotle pan sauce
39	Blue Apron	Beyond beef and quinoa enchiladas
40	Blue Apron	Cheesy vegetable quiche
41	Home Chef	Fig-Glazed Pork Tenderloin
42	Home Chef	Honey-Cider Lamb Chops
43	Home Chef	Sirloin Steak and Horse Radish Cream
44	Home Chef	Shrimp Fra Diavolo Farfalle
45	Home Chef	Weeknight Steak Bourguignon
46	Home Chef	Smoked Almond and Herbed Goat Cheese Stuffed Chicken Breasts
47	Home Chef	Italian Sausage Cowboy Pie
48	Home Chef	Thau-Style Pork Rice Bowl
49	Home Chef	Mozzarella Turkey Meatloaf and Tomato Jam
50	Home Chef	Carmelized Onion and Cauliflower Pot Pie
51	Home Chef	Buttermilk-Ranch Chicken
52	Home Chef	Chicken with Basil-Pecorino Cream Sauce
53	Home Chef	Crispy Onion Chicken
54	Home Chef	BBQ Turkey Burger
55	Home Chef	Farmhouse Fried Chicken
56	Home Chef	Parisian Bistro Bone-in Chicken
57	Home Chef	Parmesan-Crusted Chicken
58	Home Chef	Chicken Quesadillas
59	Home Chef	Thai Turkey Lettuce Wraps
60	Home Chef	Sicilian Chicken

Table 2. Mean (s.d.) meal-kit price, ingredient cost, and value-added per four servings. 2021

Company	Meal-kit Price	Ingredient Cost	Value Added
Blue Apron	31.96 (0.00)	18.36 (4.81)	13.60 (4.81)
Home Chef	35.96 (0.00)	21.57 (5.76)	14.39 (5.76)
Hello Fresh	29.96 (0.00)	18.04 (5.05)	11.92 (5.05)
All	**32.64 (2.54)**	**19.34 (5.39)**	**13.30 (5.25)**

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highest difference at \$14.39, followed by Blue Apron at \$13.60, and Hello Fresh at \$11.92. The average value-added across all meals is \$13.30. There are no statistical differences between all these values across companies, which in a highly competitive market may not be a surprise.

Times (T_h - T_c)

Let $i = 1,2,3,4,5$ index the five stages leading up to the meal kit: 1 = choose recipes, 2 = making shopping list, 3 = travel to and from grocery store, 4 = grocery shopping, and 5 = food prep of ingredients. For each stage T_{hi} is the time required of the individual in making the homemade meal-kit and T_{ci} the time required *of the individual* if the commercial meal-kit is purchased. Equation (2) then becomes

$$\begin{aligned} w &= \frac{(P_c - P_h)}{(T_{h1} + T_{h2} + \dots + T_{h5} - T_{c1} - T_{c2} - \dots T_{c5})} \\ &= \frac{(P_c - P_h)}{(T_{h2} + T_{h3} + \dots + T_{h5})} \\ &= \frac{(P_c - P_h)}{T_h}. \end{aligned} \tag{3}$$

In choosing a recipe one could always look at the commercial meal-kit recipe online but then get the ingredients yourself. Consequently, it is assumed the amount of time it takes to choose the recipe is the same for a commercial meal-kit or a homemade meal-kit, $T_{h1} - T_{c1} = 0$. Furthermore, by definition, the meal-kit company does stages two through five for the individual so $T_{c2} = T_{c3} = T_{c4} = T_{c5} = 0$. Therefore, T_h is the total hours, across the four activities, for the individual creating a homemade meal-kit expressed on a per-dinner meal (recipe) basis.

Three issues must be addressed in obtaining an estimate of T_h expressed on the required per-dinner meal basis. First, the American Time Use Survey (BLS/ATUS 2022) is the most comprehensive national representative data on time use for the US. The ATUS is a 24-hour diary recall of the activities by an individual in the household 15 years or older during the previous day. It consists of 463 disaggregate categories. While several of these are related to food production in the home (described below), none correspond to the individual meal level as required for this analysis. Second, there are economies of scope for stages 2–4. Households generally do not go to the grocery store for a single meal or every day. They plan and shop for multiple meals in a single trip so the time for these stages must be allocated to individual meals. In such a scenario, a proportional allocation rule is recommended by General Accepted Accounting Principles (GAAP: Lanen, Anderson, and Maher 2016) and we apply a proportional allocation rule to address both of these issues. Third, there are multiple recipe options so the time required across recipes (meals) can vary, depending on the complexity of the recipe and an individual's skill level.

These three issues imply any single-point estimate of T_h will be misleadingly precise. GAAP recommend doing sensitivity analysis when invoking proportional allocation rules. A parametric bootstrap (e.g., Davidson and MacKinnon 1993) is the most systematic, comprehensive, and efficient way to account for these and other uncertainties. By definition generating a distribution for T_h will cover the range of actual times under different assumptions. In addition, having a distribution of time will reveal how the implicit wage rate changes as the time requirement changes and thus provides a convenient table for considering the value of different time requirements.

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Table 3. Estimated time for stages in homemade meal-kit production. 2021

Homemade-Made Meal-Kit Variables	Estimated Average Daily Minutes Allocated to Homemade Meal-Kit Production (s.d.)	ATUS Categories[a]	Average Total Daily Minutes, Those Engaged in Activity (s.d.)	Proportional Allocation Factors for Dinner Meal[b]
Food Prep for Homemade-Made Meal-Kit (T_{h5})	37.40 (35.80)	Food Preparation	51.23 (49.03)	0.73
Grocery Store Travel for Homemade-Made Meal Kit (T_{h3})	4.21 (3.10)	Travel Related to Grocery Store	24.79 (18.10)	0.17
Grocery Shopping for Homemade-Made Meal Kit (T_{h4})	8.15 (5.59)	Grocery Shopping	47.94 (32.86)	0.17
Make Shopping List for Homemade-Made Meal Kit (T_{h2})	3.91 (5.20)	Personal Organization and Planning	26.06 (34.86)	0.15

[a]ATUS codes – Food Preparation = 020201, Travel Related to Grocery Shopping = 180701, Grocery Shopping = 070101, Personal Organization and Planning = 020902. b.See text for details on proportional allocation factors.

Table 4. Hour (mins) percentiles per day homemade meal-kit and implicit wages[a]

Hours Percentile	95th	75th	50th	25th	5th
Hours (mins.)	1.95 (117)	1.20 (72)	**0.85 (51)**	0.56 (34)	0.28 (17)
Implicit Wages					
Blue Apron	6.98	11.37	**15.94**	24.30	48.35
Home Chef	7.39	12.03	**16.86**	25.71	51.16
Hello Fresh	6.12	9.97	**13.97**	21.30	42.36
All	6.83	11.12	**15.59**	23.76	47.28

[a]See text for explanation of derivations.

In correspondence with the 2021 commercial meal-kit data, the 2021 ATUS data is used Bureau of Labor Statistics 2022, which contains observations on 9087 individuals/households. Final sample weights are used for all analysis. Table 3 gives the average minutes per day estimates for each of the homemade meal-kit production stages. Following the proportional allocation rule approach, because the meal-kits are dinner-type meals, we assumed dinner would be prepared in the interval of 4:00 to 8:00 PM. This time range accounts for 73% of all food preparation time in a day on average and gives an average of 37 minutes for food prep for the homemade meal-kit. Grocery store travel, shopping, and making a shopping list are all economy-of-scope activities. Data from Statista (2022) indicates that individuals go to the grocery store on average about 1.6 times per week, so daily grocery store travel and shopping times were converted to a weekly basis and then to a meal basis by the proportionality factor 0.17 (= 1.6/7 × 0.73) given in table 3. Regarding the grocery list time, the ATUS only collects data on an aggregate category "personal organization and planning" (code: 020902), with several of the examples given related to meal planning and carrying in groceries. We assume that on the grocery shopping day, 90% of this planning time is related to these grocery list activities. Following similar logic for travel and shopping, the dinner meal proportional time allocation factor is 0.15 (= 1.6/7 × 0.73 × 0.90). Based on these proportionality allocations, the weekly grocery store travel, grocery shopping, and shopping list times allocated to a dinner meal are estimated to be 4.21, 8.15, and 3.91 minutes on average, respectively. Thus, if an individual does all the steps (2–5) that a commercial meal-kit company does, homemade meal-kit total time would be about 54 minutes on average.

Now there is no denying that, for the three reasons cited, there is uncertainty regarding time on a per-meal basis, so to generate the parametric distribution for T_h we sum the homemade meal-kit time components for each person, conditional on the fact that the individual prepared food on the day interviewed. We then fit a gamma distribution to this variable because it is flexible and allows for various degrees of skewness of the distribution. The alpha and beta estimates are 3.24 and 17.31, respectively, and both are significant at the .001 level. These parameter estimates indicate, not surprisingly, that the underlying distribution is right-tail skewed and the mean will be greater than the median. Based on 1000 draws from this distribution the mean and median are 56 and 51 minutes in making a homemade meal-kit, respectively. The lower 5th percentile is 17 minutes and the upper 95th percentile is 117 minutes.

Results

Table 4 gives the 95th through 5th percentiles of time and corresponding implicit wages. As a reminder, it pays to make the homemade meal-kit, or equivalently not buy the commercial meal-kit, if the implicit wage is greater than the reservation wage (i.e., $w > w_r$). Table 4 provides answers to questions 2-4 and provides several insights. First, the median implicit wage rate is $15.59, which falls completely within the opportunity cost and market substitute approach ranges of $9 - $20 found in the literature. This in turn implies the conclusions about SNAP inadequacy found in the literature are not altered by the alternative implicit wage rate approach.

Going across columns in Table 4, as the amount of time decreases the incentive for preparing a homemade meal-kit intuitively increases (i.e., the implicit wage rate increases). For individuals that are at the 95th percentile (117 minutes), the homemade meal-kit is not very attractive because it takes too long and the implicit wage rate is only $6.83. Alternatively, for individuals at the 5th percentile (17 minutes), the homemade meal-kit is much more attractive because the implicit wage rate for making it yourself is high at $47.28.

Turning to the main research question of the value of online shopping, we should be clear on why meal-kits are an appropriate market good to use in estimating the value of online shopping. By definition commercial meal-kits are designed to save time and the value of the commercial meal-kit to the individual is determined in part by how much time it saves. One time component is grocery shopping time. As indicated, the numerator in the implicit wage formula is the value added of *all* time saving stages involved in transforming ingredients into a "mis en place" meal-kit but *not* expressed in units of time. The denominator places the "value added" on a per unit of time or hourly basis. Given one of the time components is shopping time, altering shopping time changes the total time and hence hourly rate. Consider a simple analogy. Suppose a company is advertising a consulting job for $1600. Your new colleague estimates it will take him 2 days (16 hours) for an hourly wage rate of $100. You review the job description and, being more experienced, realize you can do it in one day. Your hourly wage rate is therefore $200 per hour not $100. In this analogy, there are two time components (days). Removing or reducing one component changes the hourly rate. The same logic applies in reducing the shopping time as it is a component of total time in homemade meal-kit production.

Unlike the analysis of Dolfen et al. (2023), where the online shopping "convenience surplus" is measured only by the dollar value of distance saved by travel, that approach is not applicable here because SNAP benefits do not generally cover delivery charges. The time saved for the SNAP participants is purely through the shopping time saved. Obviously, the amount of time online shopping saves varies across individuals for multiple reasons (e.g., food shopping experience, shopping trip size, store size, etc.). We therefore again focus on generating a distribution for each variation in the amount of shopping time saved. Specifically, we reduce the *grocery shopping time* for each individual from the ATUS data by 50%, 75%, and 90% to reflect time saved. These amounts may seem high, but a moment's reflection indicates they are probably quite reasonable. In order to increase impulse buying, grocery stores strategically separate commonly purchased food groups (e.g., dairy, fruits, meats) so shoppers will have to walk further distances (Brisette 2018). Contrast this with how one can move from one food category to another with a click of a button when shopping online, which takes literally just seconds. In fact, the efficiency gains

Table 5. Time saved percentages: median total hours, implicit wages, and dollars gained

Shopping Time Saved	Total Hours (mins.)	Implicit Wages	Dollar Gain Per Meal[a]
0%	0.85 (51)	$15.59	0
50%	0.78 (47)	$17.12	$1.53
75%	0.73 (44)	$18.18	$2.59
90%	0.70 (42)	$18.87	$3.28

[a]Dollar gain for rows 2–4 is row implicit wage minus row 1 implicit wage $15.59.

are even greater if one uses an online shopping app, such as Instacart or USDA's own SNAP Express services (USDA 2024), which has many time-saving features, such as previous purchases, etc. Thus, online shopping is no minor time saver and the grocery shopping time-saving intervals of 50%, 75%, and 90% seem very reasonable. For each percent reduction, a new gamma distribution is fit and 1000 draws are again taken from the new gamma distribution, each with the same seed, to generate a distribution of results for each reduction. The general pattern across percentiles is the same, so Table 5 reports the 50th percentile (median) results. [A reviewer's appendix gives the full percentile table].

The first row in Table 5 is the baseline with 0% percentage time saved and just repeats the 50th percentile column from Table 4 for hours (mins.) and the implicit wage rate (all). As the amount of shopping time decreases the total hours in homemade meal-kit preparation decreases and the incentive to prepare the homemade meal-kit increases (i.e., the implicit wage rate increases). For example, if online shopping saved everyone 75% of their shopping time, a savings of 7 minutes of *total* time per meal, then the implicit wage rate would increase from $15.59 to $18.18 per hour or a gain of $2.59 per hour per homemade meal-kit produced. Consequently, if a household made between 15 and 30 meals a month, this 75% saving for each meal would be equivalent to an implicit additional $38.85 to $77.70 per month. The average SNAP benefit level for a family of 4 is $713 (CBPP 2023), so this range would amount to an implicit 5% to 11% increase in the benefits due to the time saved. Of course, the main reason for the distribution calculation approach is, just like individual household money food expenditures, time in food production will vary by household so the value of time saved will vary as well.

Discussion

As seen from the formula and the results, a major advantage of the implicit wage rate formula over the opportunity cost and market substitute approaches is that it explicitly accounts for both the money *and* time required for a specific activity. This fact allows for a more general application of the implicit wage to help explain three stylized facts about food purchases that cannot be explained with other comparable simple measures (e.g., just food price). As usual, all the following arguments should be viewed with the normal theoretical caveat of 'all else the same' (i.e., *ceteris paribus*).

First, individuals with low culinary experience or skills, either due to age or other factors, generally have a higher demand for convenience foods and commercial meal kits (Hartmann et al., 2013). As a result of their low culinary skills, they will require more time in food preparation so their implicit wage rate will be lower providing less incentive to prepare food themselves or, equivalently, more incentive to purchase convenience foods and the commercial kits.

Second, across the income distribution, data from Nielsen (2019) indicates the commercial meal-kit market is driven by those with incomes over $100k. Reservation wages increase with income (Bloemen and Stancanelli 2001). As reservation wages increase with income and surpass the implicit wage rate for homemade meal-kit production, the incentive to engage in home food production decreases. Thus, higher income operates through two channels: not only through an affordability channel but also by providing less incentive to produce meals at home with a higher reservation wage relative to a lower implicit wage.

Finally, individual households purchase a portfolio of foods across the distribution of food preparation time requirements, from basic ingredients to ready-to-eat to delivery to dining out. Across this 'degree of preparation time stream,' the implicit wage rate will vary because the numerator (value added) and the denominator (time difference) will vary depending on the food item. Being a ratio, it is then possible that the implicit wage could actually decrease at some points moving 'downstream' toward fully prepared meals, depending on the change in the market price (value added) *relative to the time* requirement. This indeed seems to be the case as stated in Candel's (2001) abstract: "The analyses also suggest that the lack of relation between the meal preparer's working status and convenience food consumption, as found in many studies, is due to convenience food **not offering enough preparation convenience** [emphasis added]. Consuming take-away meals and eating in restaurants appear to satisfy the consumer's need for convenience more adequately." Certainly, this will vary by dish/meal and skill level, and we would expect to see a portfolio of different degrees of prepared meal consumption versus home meal preparation within the same household, which is exactly what we see.

Conclusions

To improve the effectiveness of SNAP, on June 9, 2023, USDA announced that all SNAP participants could shop online. This article provides the first known estimate of the value of this policy to the individual. We introduce to the SNAP benefit adequacy literature an implicit wage approach that is conceptually more attractive than the commonly used opportunity cost and market substitute approaches because it incorporates both the money and time related to the specific activity in its calculation. The implicit wage provides simple and elegant economic insights into many aspects of food production and consumption not obtainable by just considering the money price.

Using commercial meal-kit and time-use data, we report 95th, 75th, 50th, 25th, and 5th percentile results. The 50th percentile (median) implicit wage rate of $15.59 is within the $9.00 to $20.00 range of the opportunity cost and market substitute approaches found in the literature therefore increasing our confidence that the findings from previous analyses that SNAP benefits are inadequate are robust. We estimate that if online shopping saved everyone, for example, 75% of shopping time, the median saving per hour per meal would be $2.59. This in turn would imply if a household made between 15 and 30 meals a month, this would be equivalent to an implicit additional $38.85 to $77.00 per month. For a family of four, this amounts to between an implicit 5% to 11% increase in the benefits due to the time saved. The approach also helps explain why young individuals or those with low culinary skills or with higher income are more likely to purchase convenience foods and why we see, even within a household, a portfolio of consumption across the food preparation distribution.

As with all research, the implicit wage rate approach is not a panacea and there are limitations and needed future directions. The main limitations are empirical and related to data and assumptions. A larger number of meal kits may seem desirable but as the meal kit companies charge the same rate regardless of meals chosen, any differences would stem from a larger sample of ingredients. Perhaps a greater concern is that the ingredient costs are not geographically representative, as they correspond to the Washington DC area. This is a very valid concern but is also a fact and problem with the current SNAP benefits that are based on national average prices and are thus not geographically diversified either (e.g., Christensen and Bronchetti 2020). Collecting more ingredient costs from more recipes or markets is certainly possible but is no small extension given the data collection and conversion requirements. Regarding the time measurement, it would seem the only way to get precise data on the time associated with each homemade meal-kit would be experimentally by having individuals actually do all the steps for each recipe and record the time. However, this will not alleviate the need for some allocation assumptions because of economies of scope in planning and trips for multiple meals in a single trip. It was for these reasons we did not pursue a single-point estimate approach because this would simultaneously mask the main conceptual advantage of the approach that allows the implicit wage to vary by time and would give a misleading impression of precision. Regardless of new data and different assumptions, as long as the data falls within the range of the *distribution* provided here, the results of this analysis would stand.

In closing, as with all valuing time methods, the implicit wage rate approach is empirically challenging but offers many conceptual advantages over other methods for answering important policy questions. The question of what is online SNAP shopping worth? is a fundamental question that economists will be asked to answer and is worthy of continued research and refinements beyond this first attempt.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/age.2025.2

Data availability statement. The data that support the findings of this study were (are) publicly available data found at the meal-kit companies considered and the Bureau of Labor Statistics as given in the references.

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Competing interests. The authors declare none.

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