Essays on Giffen Behavior and International Trade

A THESIS
SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL
OF THE UNIVERSITY OF MINNESOTA
BY

Ramses Yusseff Armendariz

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
Doctor of Philosophy

Timothy J. Kehoe and Pau S. Pujolas, advisers

March, 2016

Chapter 3

The History of Economic Thought about Upward Sloping Demands

3.1 Introduction

In 2008, Jensen and Miller (2008) showed that Giffen behavior (i.e. upward sloping demands) is a sign of calorie deprivation; moreover, their research suggests that Giffen behavior could be quite common among poor people in developing countries. However, in spite of these overwhelming results, economists still have not developed utility-based models to perform welfare analysis in environments of subsistence consumption and Giffen behavior, partly because no one had characterized utility functions suitable for this task.

Now, this is not an excuse anymore. Thanks to Armendariz (2015), there is an explicit utility function that can be employed for developing models of welfare analysis in environments of subsistence consumption. Therefore, it is convenient to summarize all the literature regarding Giffen behavior written until now so it can be employed to start developing the first generation of utility-based models for welfare analysis.

In this paper, I provide such a summary. In it, I describe a literature review about Giffen behavior. To facilitate the exposition, I have chosen to devide the literature

in four historical periods. Each period identifies a different set of *dialectic* debates regarding Giffen behavior. The four periods in chronological order are

1. Early period
2. Classical period
3. Empirical period
4. Synthesis period

For the unaware, *dialectics* is a systematic discussion process in which a thesis is challenged by an anti-thesis, and the conclusion of this debate is known as synthesis (O'Connor, 2003). This process can be reapeated *ad infinitum*, because every synthesis is a thesis by construction. Thus, eventually, someone challenges this new thesis with a corresponding anti-thesis, and the cycle repeats. As the reader might suspect, describing the *dialectic* process about Giffen behavior is, in fact, describing the evolution of economic thought about that topic.

The history of economic thought about Giffen behavior starts with the Early period. In this period, the thesis of Giffen behavior was born and began two dialectic debates about upward sloping demands: (1) is Giffen behavior paradoxical?, and (2) is Giffen behavior real?

The Early period is followed by the Classical period. In the Classical period, Giffen behavior stopped being a puzzle; economists realized that the theory of utility was strong enough that it could explain upward sloping demands. Nevertheless, they still left an important element unsolved: they could not contruct an explicit model that predicts upward sloping demands without using extra ingredients that are not standard in consumer theory.

In the first half of the XX century, at the time when many economists were engaged in the theory of Giffen behavior, few empirical economists noticed that Giffen behavior had not been documented. Thus, they shifted the discussion from creating models that predict this phenomenon to finding actual empirical evidence of its existence in the real world, and this gave birth to the Empirical period.

Finally, in the Synthesis period, economists succesfully documented Giffen behavior and built a model that explains this phenomenon. Today, we live in this period. That

is, today, economists have enough tools to start designing and evaluating policies that deal with Giffen behavior and subsistence consumption. This is why it is important to provide a summary of where we stand in terms of our understanding of this phenomenon. This summary reduces the time that economists spend studying the literature; and, as a consequence, it increases the time available to start solving the global problem of malnutrition.

This paper distinguishes itself from the other surveys of Giffen behavior in two ways: first, it is the first literature review to be written after Giffen behavior was succesfully modeled; and second, it focuses on how to apply our current knowledge about upward sloping demands to generate policies that target undernutrition. For example, Haagsma (2012b) only specializes in summarizing utility functions that induce upward sloping demands. Yet, it does not include Armendariz (2015).

3.2 The early period

Marshall (1895) wrote the following paragraph in the third edition of his *Principles of Economics*:

> There are, however, some exceptions. For instance, as Mr. Giffen has pointed out, a rise in the price of bread makes so large of a drain on the resources of the poorer labouring families and raises so much the marginal utility of money to them, that they are forced to curtail their consumption of meat and the more expensive farinaceous goods; and, bread being still the cheapest food which they can get and will take, they consume more, and not less of it. But such cases are rare; when they are met with they must be treated separately.

This paragraph, which later became known as the Giffen paradox, set the beginning of one of the longest debates in the history of economic thought, mostly due to Marshall's relevance as an economist in that time.

However, there were few cases of economists that referenced upward sloping demands before Giffen. One example is Gray (1815):[1]

[1] According to Masuda and Newman (1981), Rashid (1979) claims priority for the Reverend Henry

> To raise the price of corn in any degree, tends to increase the general consumption of that necessary.

In fact, I have decided to start the history of economic thought about Giffen behavior with Gray's publication. The reason is, in spite of his lack of fame, standard academia recognizes Gray as the economist who proposed this thesis for the first time.

Due to lack of evidence, I pressume that not much happened in the literature of Giffen behavior between Gray's publications and Marshall's *Principles*. As a matter of fact, Marshall believed that Mr. Giffen was the first to notice upward sloping demands (Marshall et al., 1966a). Hence, I devide the early period in two parts: pre-1895 and post-1895. In this division, Gray's statements characterize the pre-1895 part, while the dialectic debates between Marshall and other economists characterize the post-1895.

The post-1895 period contains two different dialectic debates: one theoretical and one empirical. The theoretical debate challenges Marshall's proposal of upward sloping demands as paradoxical, while the empirical debate challenges the existence of upward sloping demands. In both debates, Marshall is the main economist that defends the Giffen paradox thesis. On the other hand, the anti-theses were supported by a wide range of economists, especially in the theoretical debate.

3.2.1 Pre-1895: Gray's anti-thesis to downward sloping demands

Most economic historians today recognize Gray as the original proposer of upward sloping demands as a thesis (Masuda and Newman, 1981). However, Marshall did not know about him back then. This is why Marshall did not recognize Gray's contribution to economic theory. For instance, in the *Memorandum on Fiscal Policy and International Trade* (1903), Marshall says

> [...] as Sir R. Giffen seems to have been the first to observe, a rise in the price of wheat still leaves bread the cheapest food, which they will consent to eat in any quantity; so that, having to curtail their purchases of more expensive foods, they buy, not less bread than they would have done, but more.

Beeke who gave a brief discussion which can bear a *Giffinesque* interpretation in an unpublished paragraph of 1800.

Today, we have records about Gray's pioneering work on Giffen behavior in Schultz et al. (1938), Stigler (1965), and Rashid (1979). Yet, these references are brief and not based on Gray's original work, but on a critique that Powell (1896) wrote. Alternatively, the best known project that tried to resurrect Gray as the pioneer of upward sloping demands is Masuda and Newman (1981). Masuda employs original quotes from Gray to give him the place he deserves in the history of economic thought; he argues that upward sloping demands should be known as *Gray goods* (instead of Giffen goods).

As many other scientists, Gray tried to introduce his work in the literature by challenging standard theories. In particular, Gray used his exposition of upward sloping demands to challenge the thesis of the market as a maximizer of social welfare; but his efforts were in vain, because his writings were not widely known. In fact, Masuda refers to Gray as "a writer on economics of great pretensions but of less success" after having found that Gray wrote two other books under a pseudonym to praise his own work.

Gray has a strong proposition about Giffen behavior. He argues that not only individual demands are upward sloping but also the market one. He defends this thesis by arguing that the measure of the population that shows Giffen behavior is large enough to affect the slope of the market demand. For example, in the following paragraph, Gray conjectures that low income consumers who highly depend on wheat as the main source of food could show Giffen behavior:

> If wheat should rise only so high as to make but a difference of 2d. in the quartern loaf, I imagine, there will be no great difference in the quantity of bread eaten by a nation. The mass that lives chiefly or considerable on bread, will be urged by the rise to be more economical in that article, and use little more of others, such as potates. And this rise scarcesly sufficient to prevent that body from being able to purchase the usual, or even a larger quantity of other articles. But in proportion as the quartern loaf rises above this, will the great mass of population be obliged to confine itself more and more to bread and potatoes. When the quartern loaf, at the present price of labour with us, rises to fourteen pence, the consumption will be sensibly increased. At eighteen pence per loaf, the great body will be nearly confined to bread and potatoes. Beyond this, the poorer of the middle ranks, with large families, will be much in the same predicament.

And, in this paragraph, he conjectures that the size of the population that shows Giffen behavior is so large that they will affect the market demand:

> There is no paradox here. The cause is as clear, as the effect is unquestionable. At entering on the subject, it must be observed, that perhaps more than three fourths of the bread used, is consumed by the working classes, not only on the account of the proportion which the number of this description of population bears to the whole, but because this body lives more than the other classes on bread. if we add to these the inferior classes of tradesmen, and manufacturers with large families, who also very much live on bread and pudding, we shall perhaps find, that this mass of population consumes nine tenths of the whole quantity of bread corn.

Finally, notice how enphatic he is about how subsistence consumption induces Giffen behavior; even more, his intuition is surprisingly close to Jensen and Miller's finding 200 years later as the following quote shows:

> It will be asked, why do they not buy something else than this very thing, which is grown so dear? The answer is obvious. They have it not in their power to buy anything else.

In other words, Gray argues that poor agents do not subsitute away from this product which is increasing in price because there are no subsitutes available. The surprising element is, Jensen and Miller argue exactly the same statement when they design their experiment to find Giffen behavior among poor consumers without referencing to Gray.

3.2.2 Post-1895: the empirical debate

Marshall's thesis proposal (i.e. the demand for staples is upward sloping in the U.K.) started two dialectic debates in academia: an empirical debate and a theoretical debate.

The empirical debate was mostly between Marshall and Edgeworth. Back then, Edgeworth was an emerging academic economist in England who challenged the existence of upward sloping demands (Edgeworth, 1909). For example, Edgeworth wrote the following statement in the Economic Journal:

> Even the milder statement that the elasticity of demand for wheat may be positive, although I know it is countenanced by high authority, appears to me so contrary to a priori probability as to require very strong evidence.

Even more, Edgeworth refered to upward sloping demands as "contrary to general experience and common sense."

Despite Edgeworth's solid critique, which remained valid until 2008, Marshall did not drop his thesis. Instead, he kept the dialectic debate going. For instance, as Stigler (1947) notices, "there could be little doubt of the identity of the 'high authority, and Marshall rose to the defense of the paradox:"

> But the hint that a rather rash and random guess has been made by those who suggest that a (moderate) rise in the price of wheat might increase its consumption in England (not generally) provokes me to say that the matter has not been taken quite at random.

However, Marshall's defense is not strong enough as he still refers to personal experiences:

> Ever since I saw Giffen's hint on the subject, I have set myself to compare the amounts of bread (and cake, wheaten biscuits and puddings) eaten at first class dinners in private houses and expensive hotels, with the consumption in the middle class houses and second-rate hotels; and again with the consumption in cheap inns, including a low grade London hotel: and I have watched the baker's supplies to cottages. And I am convinced that the very rich eat less than half as much bread as the poorer classes, the middle classes coming midway. This proves nothing conclusively: but it is a fair basis, I think, for a surmise as to a probability.

Some economists stood with Marshall in this debate. For instance, Rea (1908) says, "a rise in the price of wheat would increase rather than decrease the consumption in this country." On the other hand, other economists took a more policital stand. For example, Pigou said, "I agree that it is possible that the elastcity of the English demand for wheat may be positive. This certainly used to be the case; but I doubt if it is appreciable the case now" (Rea, 1908).

3.2.3 Post-1895: the theoretical debate

In his *Principles of Economics*, Marshall proposes Consumer Surplus as an actual measure of utility. The problem is, for this to be true, it is necesary to have downward sloping demands. In other words, Giffen behavior does not fit in his theory. Even more, to make Consumer Surplus be an accurate measure of utility, the utility function must be additively separable; that is, the marginal utility of each input cannot be a function of the other inputs. For example,

$$u(x, y) = f(x) + g(y)$$

where

$$\frac{\partial f}{\partial y} = \frac{\partial g}{\partial x} = 0$$

As a consequence, Marshall's thesis started two debates in economic theory: (1) the accuracy of Consumer Surplus as a measure of utility, and (2) the possibility of upward sloping demands.

Marshall's thesis about Consumer Surplus is consistent with the standard technique for modeling preferences in the late 1800's. For instance, famous eonomists as Jevons and Walras were known for using separable utilities in the late 1870's. What's more, Pareto assures that separable utility is a good approximation of preferences because evidence suggests that demands are downward sloping (e.g. Stigler, 1947; Haagsma, 2012b).

In spite of the popularity of separable utilities, other economists challenged this view. The most prominent of this set was Edgeworth. Edgeworth proposed the general form of the utility function in 1881 (the form we currently use today). In his proposition, Edgeworth says that the marginal utility of a good does not have to be independent of the other commodities, but this anti-thesis did not have much acceptance in academia.

Constant marginal utility of money

Marshall's thesis regarding Consumer Surplus as a measure of utility also requires to assume that the marginal utility of income is constant. To understand this element, consider the following Lagrange function:

$$L = f(x) + g(y) + \lambda [I - p_x x - p_y y]$$

where x and y are consumption goods, p_x and p_y are their respective prices, I is income, and f and g are strictly increasing, strictly concave and continuously differentiable. Also, notice that this Lagrange funtion implies that λ is the marginal utility of income.

Now, I will show that the change in utility is equal to the change in Consumer Surplus when λ is constant. To begin, notice that the first order conditions characterize the demands in this case; that is, $f'(x) = \lambda p_x$ characterizes the demand for x, and $f'(y) = \lambda p_y$ characterizes the demand for y. Now, let the price of y change from p_{y0} to p_{y1}, and also let y_i be the quantity demanded for y when its price is p_{yi}. Therefore, this change in price implies that the change in Consumer Surplus is

$$\int_0^{y_1} f'(y)\, dy - \int_0^{y_0} f'(y)\, dy = f(y_1) - f(y_0)$$

in other words, the change in Consumer Surplus is equal to the change in utility.

However, according to Dooley (1988), other economists challenged this assumption as well. Some examples are Patten (1893), Baron (1894), and Nicholson (1894).[2] Unfortunately for these economists, their anti-theses had the same fate as Edgeworth's: they did not have much success academically.

Utility function that makes Consumer Surplus be a measure of utility

As far as I know, only quasi-linear utilities can make Consumer Surplus be an accurate measure of utility regardless of income (Mas-Colell et al., 1995). For example, consider the following utility function:

$$u(x, y) = x + \alpha \log y$$

Hence, in an interior solution, the demands are

$$y = \frac{\alpha p_x}{p_y}$$

$$x = \frac{I}{p_x} - \alpha$$

[2] Mason (1989) and White (1990) review this literature.

where I is income, p_x is the price of x, and p_y is the price of y. Now, let the price of y decrease by 50%. By normalizing $p_x = 1$, we find that the gain in utility is equal to $\alpha \log 2$. Notice that this number is exactly equal to the gain in Consumer Surplus.

3.3 The Classical Period

The classical period refers to the time when economists realized that the theory of utility was strong enough to predict Giffen behavior. This realization happened thanks to Eugen Slutsky, a Russian economist who published in 1915 the so called "Slutsky Equation."

The Slustky Equation is a mathematical identity that splits the total change in quantity demanded induced by a change in price into two effects: substitution effect and income effect. In principle, substitution effect is always negative; that is, an increase in the price of a commodity will make a consumer to substitute away from it (reduce its quantity demanded). In contrast, the income effect can have either a positive or a negative sign. Therefore, there is no constraints in its direction. Furthermore, its size can be large enough that it can take over the negative force from the subsistution effect. Hence, this equation redefines Marshall's Law of Demand as follows (Jehle and Reny, 2011):

> There is a negative relationship between price and quantity demanded. However, when the relationship is positive, the income effect must be negative.

Mathematically, the Law of Demand can be written in terms of elasticities:

$$\varepsilon = -\left(\kappa\eta + (1-\kappa)\,\sigma\right)$$

where ε is the price elasticity of the demand for a given commodity (call it "X"), η is the income elasticity of X, σ is the elasticity of subsitution between X and a "composite" good that aggregates all the other commodities, and κ is the proportion of income spent on X. As it can be seen in this equation, the sign of ε is ambiguous, because, even though $(1-\kappa)\,\sigma$ is always positive, the sign of $\kappa\eta$ can be negative and large enough to make the price elasticity of the demand be positive. That is, the income elasticity can make the demand show Giffen behavior.

It is important to note that, the Slutsky Equation is not a theorem of the existence of an upward-sloping demand function, but rather a statement that says that there is nothing in the theory of utility that restricts it from predicting Giffen behavior. Therefore, this equation leaves the debate regarding the existence of upward sloping demands still open until there is an explicit example of a utility function that induces Giffen demands.

Today, economists recognize Slutsky as the proponent of this identity. Yet, this recognition did not happen until after World War II ended despite of having published his proposition 30 years earlier. Originally, English-speaking economists thought that Hicks and Allen (1934) were the first to find this identity, mainly because Slutsky (1915) published in Italian. However, to avoid confusions and in order to give the credit he deserves, Allen (1936) explicitly explains that Slutsky is the original founder of this identity (Barnett, 2004).

3.3.1 Adding constraints to the Consumer Problem

Since the Early period, Marshall had a debate with other economists about the possibility of observing Giffen behavior, despite of proposing a theory that cannot explain why Giffen behavior would exist. Therefore, to show how Giffen behavior is possible without contradicting his own theory, Marshall constructed Consumer Problems with extra constraints besides the budget constraint. For instance, when Marshall was introducing one of his examples, he said

> I object to the phrase negative elasticity, because I think it tempts people to carry analytical mathematics beyond their proper scope. In this case, for instance, [an upward-sloping demand] suggests a paradox. And I submit that there is no paradox at all... What but needless perplexity can result from calling this negative elasticity, on the abstract ground that that name is in harmony with mathematical symbols, which are being pushed beyond their proper scope? (Marshall et al., 1966b)

In the examples that Marshall introduced, the consumers increase the quantity demanded as price increases, because the extra constraints force them to do so. For

instance, in a letter to Edgeworth, Marshall et al. (1966b) explains how a poor consumer may increase the distance he will travel on a cheap mean of transportation that increases its price:

> I believe that people people in Holland travel by canal boat instead of railway sometimes on account of its cheapness. Suppose a man was in a hurry to travel 150 kilos. He had two florins for it, and no more. The fare by boat was one cent a kilo, by third class train two cents. So he decided to go 100 kilos by boat, and fifty by train: total cost two florins. On arriving at the boat, he found the charge had been raised to $1\frac{1}{4}$ cents per kilo. 'Oh: then I will travel $133\frac{1}{3}$ kilos (or as near as may be) by boat, I can't afford more than $16\frac{2}{3}$ kilos by train.' Why not? Where is the paradox?

Notice that this example says that the consumer is in a hurry (that is, he needs to travel as fast as possible). Thus, the goal of this consumer is to minimize the time it will take him to travel 150 kilometers. To achieve this, he has two options: to travel by boat or by train. Travelling by train is faster than travelling by boat; however, his budget does not allow him to travel by train the whole distance. Therefore, he can opt for travelling by boat part of the journey and travelling by train the remaining part. That is, the consumer travels part of the distance by boat because he is poor. Hence, the poorer he is, the longer he will have to travel by boat; and since an increment in price makes the consumer poorer in real terms, his demand for time travelled by boat increases with price.

After Marshall's example, other economists employed this technique to explain Giffen behavior. The best known examples in this category are Pareto (1896), Wicksell (1934), Dooley (1988), and van Marrewijk and van Bergeijk (1990). In all these cases, Giffen behavior arises when a consumer is so poor that activates an extra constraint. For example, consider the Problem of a Consumer who wants to maximize his utility by buying bundles of bread (b) and meat (m) and is constrained by his budget and by a caloric requirement. In particular, let his problem be the following:

$$\max \{\log(b) + \log(m)\}$$

subject to

$$p_b b + p_m m \leq I$$
$$\alpha_b b + \alpha_m m \geq \bar{C}$$

where the former constraint is the budget constrain, and the latter is the caloric requirement. In this problem, p_b and p_m are the prices of bread and meat respectively, α_b and α_m are the calories that one unit of bread and meat provide respectively, and $\bar{C}$ is the minimum amount of calories necessary to survive.

In this problem, there are two types of solutions: either the constraint that represents the caloric requirement is active or not. In the latter type of solution, the demands for bread and meat are downward-sloping. However, when the caloric requirement constraint is active, the demand for the cheapest source of calories shows Giffen behavior.

Now, we will verify that the consumer may have Giffen behavior for the cheapest source of calories. First, assume that both constraints are active. Therefore, the solution to the consumer problem is characterized by the following system of equations:

$$p_b b + p_m m = I$$
$$\alpha_b b + \alpha_m m = \bar{C}$$

In other words, the demand for bread is

$$b = \frac{\overline{C} p_m - \alpha_m I}{p_m \alpha_b - \alpha_m p_b}$$

Now, let bread be the cheapest source of calories. That is, assume that the following inequality holds

$$\frac{\alpha_b}{p_b} > \frac{\alpha_m}{p_m}$$

Therefore, the derivative of the demand for bread with respect to its own price is positive.

3.3.2 Increasing marginal utility

Slutsky found that, when the utility is additive and convex and when theere is one good with increasing marginal utility while all the other goods have decreasing marginal utility, the income effect of the former good is positive while the income effect of all the latter goods is negative. A modern version of this insight can be found in Liebhafsky (1969).

Hence, since "Giffen goods" are inferior, Slutsky's insight suggests a recipe on how to create demands with Giffen property. A broad explanation of how this is done can be found in Silberberg and Walker (1984). In this paper, I will only provide one example shown in Haagsma (2012a)

Consider the following utility function:

$$u(x_1, x_2) = \log(x_1 - 1) - 2\log(2 - x_2)$$

and restrict its domain to $x_1 > 1$ and $0 \leq x_2 < 2$. Then, by taking the first order conditions, one can easily verify that the marginal utility of each good is positive:

$$\frac{\partial u}{\partial x_1} = \frac{1}{x_1 - 1}$$
$$\frac{\partial u}{\partial x_2} = \frac{2}{2 - x_2}$$

Moreover, notice that the marginal utility of x_2 is strictly increasing. Finally, also notice that the indifference curves are strictly convex to the origin. Thus, in an interior solution, the demand functions are characterized by the Euler Equation and the budget constraint holding with equality. That is, by solving this system of equations, the demand for x_1 is found to be

$$x_1 = 2 - \frac{1}{p_1}(I - 2p_2)$$

where I is the income, and p_1 and p_2 are the prices of x_1 and x_2 respectively.

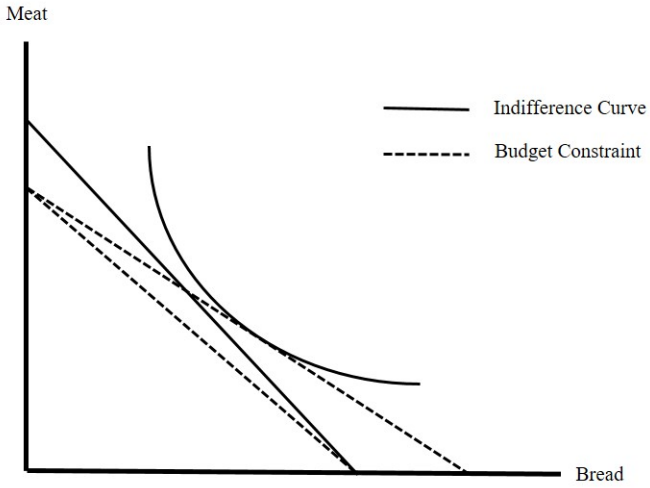
Clearly, the demand for x_1 shows Giffen behavior when $I - 2p_2 < p_1 < I - p_2$.

3.3.3 Subsistence environments may change preference ordering

In 1994, Davies (1994) published an alternative explanation for Giffen behavior. In his paper, he argues that rich consumers may order preferences differently than poorer consumers due to difference in motives. In particular, the order of preferences of rich consumers may be motivated by social values or taste, whereas the order of preferences of poor consumers may be motivated by caloric intake.

As Davies notes, the change in preferences between rich and poor consumers may induce Giffen behavior, because an increment in price makes consumers be poorer in real terms, which could lead a change in motives that order preferences. The next figure explains this point:

Figure 3.1: Indifference curves and demand for bread



3.3.4 Getting rid of the substitution effect

As it was previously mentioned, the Slutsky equation splits the total change in quantity demanded for a commodity into two effects: substitution effect and income effect. The substitution effect always pushes on the same direction, making the demand be downward sloping. Thus, in order to obtain Giffen behavior, the income effect must push in the opposite direction and be stronger than the subsitution effect. As Sorensen (2007) shows, one way to obtain this result is by creating a utility function that turns off the subsitution effect and has an inferior good. For example, consider the following utility function:

$$u(x_1, x_2) = \min\{x_1 + 1, 2(x_1 + x_2)\}$$

This utility function makes use of the min operator to create a "kink" in the indifference curves. At the kink, there is not substitution effect. Moreover, since the utility is monotone, the demand is located at the kink when the solution is interior. In particular, using this utility, the demand for x_2 is

$$x_2 = \frac{p_1 - I}{2p_1 - p_2}$$

Therefore, when $p_1 > I$ and $p_1 > p_2$, the demand for x_2 is upward sloping.

3.3.5 General Equilibrium Effects

So far, all the previous arguments try to explain Giffen behavior in highly controlled environments, where the only variable changed is the price of the commodity in question while everything else is kept constant. However, this might not be the case in reality. In fact, in his text Value and Capital, Hicks (1939) mentions how General Equilibrium effects may induce Giffen behavior even when the income elasticity of all the goods is positive:

> What happens if this is not so, if he comes to the market not only as a buyer but also as a seller? Suppose he comes with a fixed stock of some commodity X, of which he is prepared to hold back some for his own consumption, if price conditions are favourable to that course of action.
>
> [...]
>
> But what happens if the price of X varies? The substitution effect will be the same as before. A fall in the price of X will encourage substitution of X for other goods; this must favour increased demand for X, that is to say, diminished supply. But the income effect will not be the same as before. A fall in the price of X will make a seller of X worse off; this will diminish his demand (increase his supply) unless X is for him an inferior good.
>
> The significant difference between the position of the seller and that of the buyer thus comes out at once. In the case of the buyer income effect and substitution effect work in the same direction save in the exceptional case of inferior goods. In the case of the seller, they only work in the same direction in that exceptional case. Ordinarily they work in opposite directions.
>
> The position is made more awkward by the fact that sellers' income effects can much more rarely be neglected. Sellers usually derive large parts of their incomes from some particular thing which they sell. We shall therefore expect to find many cases in which the income effect is just as powerful as the substitution effect, or is dominant. We must conclude that a fall in the price of X may either diminish its supply or increase it.

Similarly, Rosen (1999a) explains thoughly that the famine experienced in Ireland in

the 1800's can be accounted by a General Equilibrium model in which the demands are normal, not Giffen. In particular, he claims the following:

> Price and quantity data prove that Irish potatoes in the 1840s were not Giffen goods. Intertemporal trade-offs required by the fact that a sizable fractions of the potato crop is needed for seed crops can produce unusual market dynamics. The Irish experience is well described by a normal demand model in which a permanent decline in the productivity of seed potatoes was at first mistaken as a transitory crop failure. These mistakes provoked "over-saving" of seed crop in a population in dire circumstances. With the benefit of hindsight, consumption of seed crop capital was warranted. Erroneous expecations of potato productivity by growers delayed necessary agricultural adjustments and contributed to the catastrophe later on.

Finally, Nachbar (1998) shows that a good is normal when its price and quantity consumed fall simultanously using a General Equilibrium model. Thus, the commodity cannot be Giffen.

3.3.6 Alternative Theories of Giffen behavior

While historically most of the literature written regarding Giffen behavior talks about this phenomenon in environments of subsistence consumption, few economists have developed theories that predict that upward sloping demands may exist in other environments. One example of this is Ng (1972). Ng suggests that consumers may solve their problem using a step-optimization instead of the standard form. This step optimization helps consumers to save on decision costs; instead, they first allocate money in different broad categories (for example, housing). Then, they choose how to spend that money allocated in each category. A price change only changes the allocation within each category, and not the allocation across categories. As Ng shows, this effect can induce Giffen behavior.

Another theory is the one presented by Garratt (1997). Garrat shows that expensive indivisible commodity may cause Giffen behavior in other (divisible) and cheap commodities. Finally, Hoy and Robson (1981) show that the demand for insurance may show Giffen behavior.

3.4 The Empirical Period

Throughout the Early and Classic periods, most economists argued about the existence of upward sloping demands based on personal experiences rather than using solid evidence. In fact, Mr. Giffen personally clarified that there is no evidence of an upward sloping demand. For instance, according to Stigler (1947), Giffen (1909) wrote in the Economic Journal the following paragraph:

> Fears are expressed that this rise in wheat will affect the consumption of the working classes seriously, and be bad for trade, but this is certainly contrary to long experience. Until 30 years ago wheat was always thought cheap when it was anywhere under 50s., and no particular bad effects on consumption were experienced from fluctuations below that figure. It remains to be seen whether there will be any different effect now from an advance to near 50s. When people have become so long accustomed to much lower figures.

Consequently, given the lack of counter-evidence, no one seriously disputed the Giffen paradox as a valid example of upward sloping demands. Yet, economists were aware that the Giffen paradox is just a conjecture, not scientific evidence nor a consistent theory.

3.4.1 Was the demand for bread or wheat Giffen in Marshall's time?

For a long time, the existence of upward sloping demands for bread and wheat in Marshall's time remained unchallenged; no economist had been able to put together facts that either support or discredit its existence. The first serious criticism against the existence of upward sloping demands in the real world came from Stigler (1947). Stigler based his criticisms on two fronts: at a market level and individual consumption level. At a market level, Stigler finds that there is a negative relationship between total quantity consumed of wheat and its price. Thus, he conjectures that the market demand cannot be upward sloping. Then, he focuses at the individual consumption level. He uses a table from the Board of Trade's 1904 study of workmen's budget to argue that the income elasticity of bread an flour was positive for low income families, which implies that the individual household demand for bread could not be upward sloping.

However, Stigler's criticism did not remain unrivaled. A year after Stigler published his critique, Prest (1948) published a comment showing that Stigler's arguments are not valid. First, Prest mentions that the quantities that Stigler employed to test the slope of the market demand are traded quantities. Thus, they cannot be employed to test the slope of the demand. Second, Prest notes that the Stigler's analysis about the income elasticity does not consider the size of the household. If such a consideration had been made, Stigler's argument would have been "weakened." And third, Prest reveals a different data set, one about agricultural laborers' families from that time, that suggest a negative income elasticity of bread and wheat. Yet, he is clear about the statistical significance of this evidence, and argues that it should not be considered as a suggestion that Giffen's conjecture is accurate.

Consequently, the debate between Stigler and Prest kept the question open until Koenker (1977) put a final answer to it. Koenker uses historical data to argue that wheaten bread and meat are both normal goods.

3.4.2 The other classical (fallacy) example of Giffen behavior

In his textbook called *Economics*, Samuelson argues that the demand for potatoes during the Irish Potatoe Famine in 1845 - 1849 is Giffen. This example became a classic in the next 30 to 40 years as many authors of textbooks of Microeconomics used it to explain upward-sloping demands. Nevertheless, despite of its popularity in economic lectures, this example is flawed. In that time, the total amount of potatoes available fell drastically. Thus, quantity demanded could have risen as a consequence. The first to notice this fallacy is Dwyer and Lindsay (1984), and another reference that explains how the market demand for potatoes could not have been Giffen is McDonough and Eisenhauer (1995). Aletrnatively, Rosen (1999a) shows a theory that explains what caused the Irish Potatoe Famine.

3.4.3 Creating evidence in laboratories

Fueled by the unsuccesful attempts to find "real World" evidence of upward sloping demands and by the rising popularity of Experimental and Behavioral Ecomomics, some scientists started to run experiments in highly controlled environments to generate

upward sloping demands. The two best known cases are Battalio et al. (1991) and DeGrandpre et al. (1993). Battalio et al. (1991) uses rats to show they have an upward sloping demand for a quinine solution while root beer was a normal good. Alternatively, DeGrandpre et al. (1993) used 7 smokers to show that less preferred brands of cigarrets are inferior commodities for them. Even more, 2 out of those 7 smokers showed upward sloping demand for the less preffered brands.

3.5 The Synthesis Period

The Synthesis Period refers to the time when both things happened: first, rigorous evidence of upward sloping demands was found; and second, an explicit utility function that models the Giffen paradox was characterized.

Jensen and Miller (2008) found evidence of upward sloping demands in an experiment they performed in two Chinese regions where a significant fragment of the population lives in conditions similar to those described in the Giffen Paradox. Jensen and Miller's experiment consisted on subsidizing the prices of dietary staples for extremely poor households in the Chinese provinces of Hunan and Gansu. In their experiment, they found strong evidence of Giffen behavior for rice in Hunan, and weaker evidence for wheat in Gansu.

Specifically, their experiment consisted on subsidizing the primary staple of randomly chosen houses who live in "subsistence conditions" for five months. This subsidy was intended to test the change in quantity consumed of the staple as a response to the change in its price. Jensen and Miller found that the experimental subsidy caused households to reduce their demand for rice in Hunan and for wheat in Gansu, and removing the subsidy had the opposite effect.

The relevance of Jensen and Miller's finding is that their experiment suggests that Giffen behavior may be quite common among poor people in developing countries, despite of not having been documented earlier. What makes it even more relevant is that Giffen behavior is a sign of starvation, which definitely calls for immediate intervention.

When Jensen and Miller published their findings, theoretical economists had not developed a utility function that rationalizes their observations yet. Instead, we had to wait for another 6 years for this characterization. In 2014, as part of my Job Market

Paper, I presented the first characterization of a utility function that rationalizes Jensen and Miller's observations and models preferences that match the description of the Giffen paradox.

3.5.1 The Giffen Paradox Utility Function

120 years ago, Marshall (1895) said that a rise in the price of bread, a primary staple for low income consumers back then, caused poor British families to buy more bread. Today, economists refer to this statement as the Giffen paradox.

Ever since Marshall published the Giffen paradox, the theoretical possibility of upward sloping demands (i.e. Giffen behavior) has been profoundly divulged. In fact, it has been included in virtually every upper level textbook of microeconomics (e.g. Mas-Colell et al. (1995), Jensen and Miller (2011), and Varian (1992)). And, as the Slutsky Equation testifies, economic theory cannot rule out the possibility of predicting upward sloping demands using solely a budget constraint and a utility function that is strictly increasing, strictly quasi-concave, and continuously differentiable. Consequently, it is highly surprising that, after all this time, no one has explained the Giffen paradox under these conditions yet. In particular, this theoretical emptiness has forced upper level textbooks to explain Giffen behavior by either drawing indifference curves or showing that the Slutsky Equation does not rule out that possibility. So far, there are two attempts to explain the Giffen paradox using a utility function. The first attempt employs an extra constraint besides the budget constraint (e.g. Dooley (1988) and van Marrewijk and van Bergeijk (1990)), and the second attempt uses a non-differentiable utility function (Davies, 1994).

Now, the search for such a utility function is an official mathematical challenge called the Strong Giffen Problem (Heijman and von Mouche, 2012a). Specifically, the Strong Giffen Problem is to propose a "concrete utility function that is strictly increasing and quasi-concave [...] where the Giffen property can be shown by solving the equation of budget balancedness together with the equation saying that the price ratio equals marginal rate of substitution." So far, a very few number of economists have reached a level of completeness in this task (e.g. Wold (1948), Moffatt (2002), Sorensen (2007), and Doi et al. (2012)).[3] Yet, none of these examples model the subsistence consumption

[3] Haagsma (2012b) summarizes many theories of upward sloping demands.

environment portrayed in the Giffen paradox; instead, their only purpose is to generate upward sloping demands. Moreoever, after finding the first evidence of upward sloping demands in a real world environment that replicates the Giffen paradox, Jensen and Miller (2008) turned this mathematical challenge into a scientific puzzle.[4]

In this section, I construct the first concrete utility function that models the Giffen paradox and solves the Strong Giffen Problem. Furthermore, after adding a simple adaptation, this utility function can account for Jensen and Miller's 2008 finding regarding Giffen behavior (i.e. an inverted "u-shape" relation between income and price elasticity of the demand for bread, where the poorest of the poor and the least poor have downward sloping demands and the consumers in the middle show Giffen behavior.)

The utility function I propose represents CES preferences for two hedonic characteristics of food: calorie surplus and flavor. I define calorie surplus as total calories consumed minus a minimum amount of calories to survive. To ingest calories, the consumer must buy bread or meat. Bread and meat are perfect substitutes at the provision of calories. However, meat is the only food that provides flavor as well. This utility function is strictly increasing, strictly quasi-concave, and continuously differentiable; it solves the Strong Giffen Problem, and its properties allow to derive the demands in close form.

To account for Jensen and Miller's finding, I turn the utility function into a piecewise function: the utility function is CES when calorie surplus is a strictly positive number; otherwise, the utility function equals to the value of calorie surplus. With this adaptation, the utility function rationalizes the indifference curve map drawn by Jensen and Miller to explain their findings and, as a consequence, it rationalizes the inverse "u-shape" relation between income and price elasticity of the demand.

The utility function I propose in this paper unifies two theories regarding Giffen behavior: Lancaster (1966) and Davies (1994). The CES piece of the utility function materializes Lancaster's theory of hedonic preferences, where consumer preferences are defined over a set of non-market characteristics; and, to obtain these characteristics, consumers must go to the markets to buy commodities. This utility function is the first explicit example of how Lancaster's theory can rationalize Giffen behavior.[5] The

[4] Jensen and Miller used an indifference curve map to explain the theoretical background of their findings.

[5] Lipsey and Rosenbluth (1971) show that Lancaster's theory can explain Giffen behavior; yet, they

other piece of the utility function materializes Davies's theory. As Davis proposes, consumption priorities change when the consumer is reduced to a subsistence condition. As a consequence, caloric intake becomes the only service that the consumer cares about.

The utility function

The utility function represents a preference relation over two services: *calorie surplus* and *flavor*. These services cannot be bought in the markets separately. The consumer must go to the markets to buy bread and meat to obtain these services.

Calorie surplus is defined as total calories consumed from eating bread and meat minus a calorie requirement to survive. Therefore, its production function is

$$c = \alpha_b b + \alpha_m m - \bar{c} \tag{3.1}$$

where c is calorie surplus, b is the quantity of bread consumed, α_b is the calories that each unit of bread provides, m is the quantity of meat consumed, α_m is the calories that each unit of meat provides, and $\bar{c}$ is the calorie requirement to enjoy flavor.

Flavor is an abstract service that can only be produced using meat as an input. Its production function is δM, where δ is the amount of flavor that each unit of meat provides.

The functional form of the utility is

$$u(b, m) = [(\alpha_b b + \alpha_m m - \bar{c})^\rho + (\delta m)^\rho]^{\frac{1}{\rho}} \tag{3.2}$$

where $\sigma = {}^1/_{(1-\rho)}$ is the elasticity of substitution between calorie surplus and flavor.

Properties of the utility function

The utility function is strictly increasing, strictly quasi-concave, and continuously differentiable on bread and meat. It satisfies Inada Conditions on meat, while the marginal utility of bread is finite when the consumption of bread is zero and tends to zero as the consumption of bread grows unboundedly. Thus, the indifference curves are differentiable, downward-sloping, and strictly convex to the origin.

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do not provide a concrete example.

Deriving the demands

According to the theory of utility, the demand for bread and meat is the solution to the consumer problem. The consumer problem is defined as choosing an affordable basket of bread and meat such that maximizes the utility. That is,

$$\begin{aligned} \max_{\{b,m\}} u(b,m) \quad s.t.: \quad & p_m m + p_b b \leq i \\ & m, b \geq 0 \end{aligned} \tag{3.3}$$

where i stands for income, p_b for the price of bread, and p_m for the price of meat.

Since the utility function is strictly increasing, the budget constraint holds with equality in the solution. That is, $p_m m + p_b b = i$. And, due to Inada Conditions on meat, we know that the consumer will always buy meat in the optimum. Thus, there are two solution types: either the solution is interior (i.e. the consumer purchases a positive amount of bread and meat), or the consumer spends all her budget on meat.

In an interior solution, the demands are characterized by the budget constraint holding with equality and the Euler Equation (the marginal rate of substitution equals the ratio of prices). After solving this system of equations, the demands become

$$b = \frac{i\left(\delta - \mu\left(p_b, p_m\right)\alpha_m\right) + \mu\left(p_b, p_m\right) p_m \bar{c}}{p_b\left(\delta - \mu\left(p_b, p_m\right)\alpha_m\right) + \mu\left(p_b, p_m\right) p_m \alpha_b} \tag{3.4}$$

$$m = \frac{\mu\left(p_b, p_m\right)\left(i\alpha_b - p_b\bar{c}\right)}{p_b\left(\delta - \mu\left(p_b, p_m\right)\alpha_m\right) + \mu\left(p_b, p_m\right) p_m \alpha_b} \tag{3.5}$$

whereμ is the following function:

$$\mu\left(p_b, p_m\right) = \left(\frac{p_m\alpha_b - p_b\alpha_m}{p_b\delta}\right)^{\frac{1}{\rho-1}} \tag{3.6}$$

Giffen behavior in the demand for bread

I will simplify the proof by constraining the utility function to the Cobb-Douglas case. That is, when $\rho = 0$. To see the general proof, go to Armendariz (2015).

According to Marshall's version of the Giffen paradox, bread was the cheapest food that families could obtain. In this model, I will interpret that as bread being the cheapest source of calories. That is,

$$\frac{\alpha_m}{p_m} < \frac{\alpha_b}{p_b} \tag{3.7}$$

Also, I will constraint consumer to being poor enough that they cannot survive buying bread only, but no so poor that they cannot afford meat to live. That is,

$$\frac{p_b\bar{c}}{\alpha_b} < i < \frac{p_m\bar{c}}{\alpha_m} \tag{3.8}$$

Finally, the Cobb-Douglas case has the pecularity that can make bread be a normal good, depending on the ratio of prices. The problem is, very poor consumers may run out of budget before bread becomes an inferior good. To avoid this case, I will also constraint income to be

$$\frac{p_m\bar{c}}{2\alpha_m} < i \tag{3.9}$$

I use the derivative of the demand for bread with respect to its own price to prove that the demand for bread shows Giffen behavior. I show that the value of the derivative is strictly positive when the price of bread is close enough to its upper bound defined by (8).

The derivative of the demand for bread with respect to its own price is

$$\frac{\partial b}{\partial p_b} = \frac{p_b^2\alpha_m\left(p_m\bar{c} - 2\alpha_m i\right) + p_m\alpha_b i\left(2p_b\alpha_m - p_m\alpha_b\right)}{2p_b^2\left(p_m\alpha_b - p_b\alpha_m\right)^2} \tag{3.10}$$

First, notice that the denominator is strictly positive. Therefore, (10) is positive whenever its numerator is positive.

Second, plug the upper bound for the price of bread, that is

$$p_b = \frac{i\alpha_b}{\bar{c}} \tag{3.11}$$

Thus, by plugging (11) into the numerator of (10), we find that (7), (8), and (9) make the numerator positive.

And third, by continuity, the demand for bread shows Giffen behavior at any price of bread close enough to (11).

3.6 Conclusions

This paper showed the history of economic thought regarding Giffen behavior. It devided the history into four different periods: Early, Classical, Emprical, and Synthesis. Each period refers to a particular set of dialectic debates happening in economic literature regarding Giffen behavior.

In the Early period, the thesis of Giffen behavior was born and began two dialectic debates about upward sloping demands: (1) is Giffen behavior paradoxical?, and (2) is Giffen behavior real? In the Classical period, Giffen behavior stopped being a puzzle; economists realized that the theory of utility was strong enough that it could explain upward sloping demands. Nevertheless, they still left an important element unsolved: they could not contruct an explicit model that predicts upward sloping demands without using extra ingredients that are not standard in consumer theory.

In the first half of the XX century, at the time when many economists were engaged in the theory of Giffen behavior, few empirical economists noticed that Giffen behavior had not been documented. Thus, they shifted the discussion from creating models that predict this phenomenon to finding actual empirical evidence of its existence in the real world, and this gave birth to the Empirical period.

Finally, in the Synthesis period, economists succesfully documented Giffen behavior and built a model that explains this phenomenon. Today, we live in this period. That is, today, economists have enough tools to start designing and evaluating policies that deal with Giffen behavior and subsistence consumption. This is why I provided a summary of where we stand in terms of our understanding of this phenomenon. This summary reduces the time that economists spend studying the literature; and, as a consequence, it increases the time available to start solving the global problem of malnutrition.

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