Tipping as a strategic investment in service quality: An optimal-control analysis of repeated interactions in the service industry

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TIPPING AS A STRATEGIC INVESTMENT IN SERVICE QUALITY: AN OPTIMAL-CONTROL ANALYSIS OF REPEATED INTERACTIONS IN THE SERVICE INDUSTRY*

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Abstract

We present an optimal-control model where tipping behavior creates reputation that affects future service. Tipping and reputation can evolve in four path prototypes: converging to an interior equilibrium; converging to minimum tips and reputation; and two prototypes that start differently but end with tips and reputation increasing indefinitely. Analyzing the interior equilibrium suggests that when reputation erodes more quickly (capturing lower patronage frequency), equilibrium reputation is lower. Interestingly, however, tips may be higher. Increasing the minimal tip raises tips by the same increase, and does not change reputation. A more patient customer leaves higher tips and reaches a higher reputation.

JEL codes: L83, D11, Z13, C61

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1. Introduction

Tipping is a social norm that has gained increased attention in recent years, and for good reasons. One important reason is the economic significance of tipping. In the U.S., tips in the food industry are estimated to be around $42 billion annually, and obviously adding tips in additional industries and countries will result in a much higher figure.[1] In addition, millions of workers in the U.S. derive most of their income from tips (Wessels 1997), tipping is prevalent in numerous countries and occupations (Star 1988), and tipping is related to various areas in economics (Azar 2003). Another reason for the interest in tipping is that tipping is intriguing from an economic perspective. The traditional assumption in economics that people are self-interested and maximize their utility suggests that they should not leave money to others voluntarily, as people do when they tip (especially in the case of non-repeating customers who do not intend to visit the same establishment again). The prevalence of tipping even among non-repeating customers implies that psychological and social motivations have an important role in explaining certain economic behaviors (additional examples for this are gift giving and donations).

[1] The extent of tipping has to be estimated because tips are often unreported for tax purposes (according to Hemenway (1993), the only income with a lower compliance rate is illegal income). Sales in the U.S. in 2005 of food and alcoholic beverages to consumers in full-service restaurants, snack and nonalcoholic beverage bars, bars and taverns, and lodging places, were $164.8, $16.9, $15.3, and $25.2 billion, respectively (U.S. Census Bureau 2006, Table 1269; the numbers are a projection). Summing the four numbers gives sales of $222.2 billion. A recent study of tipping in various restaurants (Parrett 2003, Table 14) found that the average tip percentage (a simple average) was 23.22%. However, average tip amount was $6.52 and average bill size was $34.67, indicating that the weighted average (weighted by the bill size) was a tip of 18.8%. Being conservative, we multiply the latter percentage by $222.2 billion to get estimated annual tips of $41.8 billion.

Much of the literature on tipping is empirical and experimental, and reviewing it is beyond the scope of this article; the interested reader can refer to the literature reviews offered in Lynn and McCall (2000a), Lynn (2006), and Azar (2007a, 2007b). Papers devoted to theoretical models of tipping, however, are much fewer. The first economic model of tipping was introduced by Ben-Zion and Karni (1977). In their model, a customer chooses the tip and the demanded effort level, while the service provider chooses how many hours to work and what level of effort to supply. The equilibrium is defined as the point in which the demand and supply of effort are equal. The model suggests that the service provider supplies more than the minimal effort level only if the marginal reward for effort is positive. It also shows that tipping by non-repeating customers is inconsistent with rational self-interested behavior.

Jacob and Page (1980) examine buyer monitoring in general, and conclude that for certain parameter values, firms should use both buyers and owners to supervise employees. Schwartz (1997) claims that the low correlation between tips and service quality refutes the argument that tipping is an efficient quality-control mechanism. He suggests that tipping exists because it increases the firm's profits. Using a theoretical model, he shows that tipping can increase the firm’s profits when consumer segments differ in their demand functions and their propensity to tip. Ruffle (1999) presents a psychological game-theoretic model of gift giving where players' utility is affected by their beliefs and emotions such as surprise, disappointment, embarrassment, and pride. He then discusses how his model can be applied to tipping, suggesting that a customer who intends to tip generously but who looks like someone that tips poorly, should tip before the service is provided rather than afterwards.

Azar (2004a) examines how firms should respond to tipping (or to other incentives that are not provided by the firm) when choosing monitoring intensity of workers. Increase in the sensitivity of tips to service quality reduces optimal monitoring intensity but nevertheless increases effort and profits unambiguously. The model helps to explain why U.S. firms supported tipping in the late 19th century but raises the possibility that European firms make a mistake when they replace tips with fixed service charges. Azar (2004b) presents a model of social norms evolution and shows that when a norm is costly to follow and people do not derive benefits from following it except for avoiding social disapproval, the norm erodes over time. Tip percentages in the U.S., however, increased over the 20th century, suggesting that people derive benefits from tipping, such as impressing others and improving their self-image as being generous and kind. Azar (2005a) incorporates social norms and feelings of fairness and generosity in the customer's utility function. He finds that while in general tipping improves service quality and social welfare, the equilibrium is crucially affected by the sensitivity of tips to service quality. When this sensitivity is high, tipping can serve as a good monitoring mechanism and support an equilibrium with a high service quality. The lower this sensitivity is, the lower and farther away from the social optimum is equilibrium service quality.

In this paper we present a dynamic model of tipping that addresses the role of tipping as a strategic investment in reputation and consequently in future service quality. In many cases (see for example Parrett 2006, for evidence from the restaurant industry), customers of services in which tips are common are repeating customers, who frequent the service establishment on a regular basis. This creates a completely different situation with different incentives for the customer and the service provider compared to a one-shot game between a non-repeating customer and a service provider. It is therefore important to analyze the case of repeating customers in a dynamic model that takes into account the repeated interactions, and yet the previous theoretical articles on tipping focus on static models that do not address the dynamics and the evolution of such repeated interactions. Consequently, the model we present adds a new dimension to the theoretical literature on tipping.

We assume that the service provider gives better service in future encounters to customers who were generous in the past. This assumption is consistent with empirical findings showing that waiters give better service when they expect larger tips (Barkan and Israeli 2004).[2] As a result, the customer has an incentive to tip generously in order to improve service quality in the future. Moreover, in line with empirical research on tipping and previous theoretical models, tipping in our model also provides psychological utility. On the other hand, tipping has a monetary cost. Using an optimal-control theoretical framework where tip is the control variable and reputation is the state variable, we examine the optimal path of tipping.

We find that tipping and reputation can evolve over time in four types of paths: (A) Converging to an interior stationary equilibrium with tips above the minimal level and positive reputation; (B) Tipping decreases first and then increases indefinitely, while reputation increases indefinitely from the beginning; (C) Tipping converges to the minimal tip and reputation converges to zero; and (D) Tipping and reputation increase indefinitely from the beginning. We then examine how the interior stationary equilibrium changes when the parameters of the model change. It turns out that when the reputation erodes more quickly (which corresponds to the case of customers who purchase the service less frequently), reputation in equilibrium is lower. Interestingly, however, tips are not necessarily lower – depending on the specific parameters and the utility function, tips might even be higher than those of more frequent customers. We also find that when the minimal tip increases, equilibrium tips are raised by the exact same increase,

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[2] A more detailed discussion of the justification for this assumption appears in the next section.

and equilibrium reputation does not change. Finally, a more patient customer leaves higher tips and reaches higher reputation in equilibrium.

The rest of the paper is organized as follows. Section 2 presents the model. Section 3 analyzes the customer's problem and finds the various optimal paths of tipping, illustrating how tipping and reputation might evolve over time. Section 4 examines how the parameters of the model affect the interior stationary equilibrium. Section 5 discusses related findings in the empirical literature on tipping behavior, and the last section concludes.

2. The Model

Consider a customer who is interested in receiving a given service (e.g., a dinner, a haircut, a car wash) repeatedly over a certain period of time (from time 0 to time T, where we assume that $T \to \infty$). The customer's utility from the service is denoted by the function $\phi(S)$, where S is service quality. We assume that $\phi'(\bullet) > 0$ and $\phi''(\bullet) < 0$. That is, the customer enjoys more when he receives better service, but the marginal utility from service quality is diminishing. In return for the service, the customer pays a price, and he may add a voluntary tip for the service provider. In different industries and different countries tipping practices differ significantly (Star 1988). In some occupations tipping exists but many people choose not to tip (e.g., tipping hotel chambermaids in the U.S.), while in other situations (such as U.S. restaurants) virtually everyone tips (Azar 2006). Consequently, in some industries the minimum tip that people leave is zero, while in others there is some positive minimum threshold of tips such that virtually everyone tips at least this threshold.

In order to have a general model that applies to both situations, we assume that the minimal tip[3] is equal to $t_n \geq 0$. The customer can choose any tip, denoted by t, as long as $t \geq t_n$. Situations where not everyone tips correspond to $t_n = 0$. In other situations, however, the norm of tipping might be so strong that everyone tips at least $t_n > 0$. The reason that everyone tips at least $t_n > 0$ can be that the norm of tipping (at least t_n) in this situation is so strong that when a customer does not tip at least t_n, he experiences a disutility (caused by disobeying the social norm)[4] that is higher than the utility from the monetary gain (saving the tip amount). Consequently, utility maximization implies that the customer always tips at least t_n. Because t_n is determined by the social norm about tipping in the relevant industry, and since it is cumbersome to use "the minimal amount that the social norm dictates one should tip," we henceforth refer to t_n simply as either "the tipping norm" or "the minimal tip."

In addition, because the customer is a repeated customer, over time the service provider can remember the customer's tipping behavior in the past and respond to it in future encounters. In order to have a tractable model, we assume that the service provider adopts a simple rule, according to which the service quality he provides is an increasing function of the customer's reputation (denoted by R).[5] Suppose further that the service quality provided increases with the

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[3] We assume for simplicity that the bill in each tipping occasion is the same, so it does not matter whether the minimum tip is a certain amount or a certain percentage of the bill.

[4] When a social norm to tip exists in a certain situation, people who disobey it feel embarrassed, guilty, and unfair (see Azar 2006, 2007b).

[5] Service quality being an increasing function of generosity in the past can result from several reasons. First, the service provider might simply reciprocate to past behavior of the customer (for a discussion of such behavior in

customer's reputation level at a decreasing rate. That is, $S = S(R)$, where $S'(R) > 0$ and $S''(R) < 0$. The lowest possible reputation is normalized to be 0, and it yields the minimal service quality, $S(0) = \tilde{S}$.

Research on tipping suggests that customers derive utility not only from obeying the norm, but also from tipping above the norm, because of psychological reasons such as willingness to feel generous, to show gratitude, and to help service providers who depend on tips as a major source of income. For example, Azar (2004b) shows that during the 20th century tips in restaurants and taxis went up, a phenomenon that suggests that people derive utility from tipping above the norm. Azar (2006) asked people in the U.S. and Israel why they tip in restaurants, letting them choose as many answers out of seven possible answers as they wished. While the reasons related to tipping being a social norm (tipping being the social norm, and feeling guilty or embarrassed when not tipping) were also common, two reasons that are not directly related to tipping being a social norm were also marked often. In the U.S., 67.8% of the respondents

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restaurants, see Azar 2007b; for a literature review of reciprocity motivations in economic behavior, see Fehr and Gachter 2000). In addition, Brenner (2001) suggests that tipping a service provider in advance, even though it eliminates the economic motivation for good service (because the tip can no longer depend on service quality), often results in excellent service because the service provider feels obligated to reciprocate. Second, people who tip more generously also have the potential to change their tips more based on service quality (because they can give a higher punishment by tipping only t_n, for example), so the service provider has higher incentives to satisfy them. In accordance with our assumption that service is increasing in reputation, Ginsberg (2001) mentions that waiters give better service when they expect the customer to be a generous one (even when they do not know him yet, but only base their conjecture on dress and other signals). Also supporting our assumptions is the study by Barkan and Israeli (2004) who find that waiters are good at predicting their tips and that they give better service to parties that are predicted to leave larger tips.

indicated that they tip because "By tipping I can show the waiter my gratitude for his service" and 66.9% indicated the reason "Waiters get low wages and depend on my tips to supplement their income" (in Israel the percentages were 68.9% and 32.4%, respectively). There is no apparent reason why someone who tips to show his gratitude or because the waiter depends on tips should derive utility from tipping only up to a certain level (the tipping norm) but not above it.

We allow for such tipping motivations (to tip above the norm) by adding to the customer's utility the function $\psi\left(t-t_n\right)$. We assume that the customer has additional psychological utility (i.e., utility that comes from psychological benefits, as opposed to utility derived from consumption) when he tips more, but that the marginal psychological utility is decreasing: $\psi'(\bullet)>0$ and $\psi''(\bullet)<0$.

Finally, if we add to the above the monetary cost of the tip and assume that the customer's utility function is separable and additive in its various components and quasi-linear in money, the utility function at time $0 \le k \le T$ may be written as

$$U(k) \ = \ \phi\left\{S\left[R(k)\right]\right\} \ + \ \psi\left(t(k)-t_n\right) \ - \ t(k) \ . \tag{1}$$

Suppose now that the tipping reputation is built up as a result of past tipping behavior. Because everyone tips at least t_n, it is natural to assume that reputation increases as a function of the difference between the tip the customer chooses and t_n. In addition, reputation is also eroded over time. Service providers forget some of the tipping behavior they observed in the past, for example. Moreover, if someone with positive reputation tips only t_n at a certain period, his reputation should fall rather than stay unchanged, and this is also captured when we introduce reputation deterioration. Denoting the instantaneous rate of reputation deterioration by δ (where

$\delta > 0$) and using the standard notation in which a dot above a variable is the derivative of the variable with respect to time (k), the change in the customer's reputation level at instant k is:

$$\dot{R}(k) = t(k) - t_n - \delta R(k) \quad . \tag{2}$$

The value of δ may depend on various things, such as the frequency with which the customer purchases the service (patronage frequency in short). Waiters, for example, are likely to remember the tipping behavior of a customer who visits a restaurant every day better than the behavior of a customer who visits once a month; therefore, a lower value of δ captures a higher patronage frequency. In addition, δ is related to the number of waiters in the restaurant or their turnover rate. In restaurants with relatively few waiters, or with waiters who retain their jobs for many years, a customer with a given patronage frequency encounters each waiter (on average) more frequently than he encounters each waiter in a restaurant with more waiters or higher waiter turnover (i.e., waiters who retain their jobs for shorter periods). Therefore, in the latter restaurant the customer's reputation erodes more quickly (because of the longer time between two encounters with the same waiter), corresponding to a higher value of δ.

3. Evolution of Tipping and Reputation

The customer's problem is to choose a path of tipping over his planning horizon that maximizes the present value of his overall utility,

$$Max \int_0^T U(k) e^{-\rho k} dk = Max \int_0^T \Big[\phi\big\{S\big[R(k)\big]\big\} + \psi\big(t(k) - t_n\big) - t(k) \Big] e^{-\rho k} dk , \tag{3}$$

where future utility is discounted at a constant exponential rate ρ, subject to the motion equation for reputation (2), the constraint on the level of tipping, $t(k) \geq t_n$, and the starting level of reputation, $R(0)$. Assuming that at time 0 the customer has no reputation at all, we set $R(0) = 0$.

The customer's problem may be viewed as an optimal-control problem which involves a state variable, $R(k)$, and a control variable, $t(k)$. The control variable (the tip given) influences the objective function (3) directly (through its own value) and indirectly through the impact on the evolution of the state variable (the customer's reputation). By choosing an optimal path of tipping over time, the customer also determines the path for his reputation and consequently also for service quality. Applying Pontryagin's maximum principle, the current-value Hamiltonian corresponding to the customer's problem is

$$H = \phi\left\{S\left[R(k)\right]\right\} + \psi\left(t(k) - t_n\right) - t(k) + \lambda(k)\left[t(k) - t_n - \delta R(k)\right], \tag{4}$$

where $\lambda(k)$ is a co-state variable which indicates the shadow price of reputation in present-value utility units, the shadow price being the subjective value assigned by the customer to a reputation unit. For an interior solution ($t > t_n$), the maximum principle conditions are:[6]

$$H_t = \psi' - 1 + \lambda = 0 \rightarrow \lambda = 1 - \psi' \tag{5}$$

$$\dot{\lambda} = \rho\lambda - H_R \rightarrow \dot{\lambda} = \lambda(\rho + \delta) - \phi' S' \tag{6}$$

$$\dot{R} = t - t_n - \delta R . \tag{7}$$

[6] Here and below we omit the time notation and the arguments of the functions when no confusion is expected for the sake of brevity. Subscripts after H stand for partial derivative of H (see equation (4)) with respect to the subscript variable.

Equation (5) is the first-order condition for optimal tipping, and it captures the idea that at the optimum (of an interior solution), the marginal cost of tipping another dollar (which is equal to one) is equal to the marginal benefit, that comes from two sources: the utility value of the increased reputation, which equals λ; and the marginal psychological utility, ψ'. Equation (5) implies that the optimal tip depends on the shadow price of reputation (λ) but is independent of the reputation level itself (R). Because utility is increasing in service quality which increases in reputation, λ must be positive. It thus follows that at the optimum $\psi'(t) < 1$. A necessary condition for the tip to be higher than t_n is $H_t\big|_{t=t_n} > 0$, from which it follows that $\lambda > 1 - \psi'(0)$. It would be convenient to eliminate λ from the analysis, so that the optimal solutions remain only in terms of the tip and reputation variables. Differentiating Equation (5) with respect to time yields:

$$\dot{\lambda} = -\psi''\dot{t}\ . \tag{8}$$

Combining Equations (5), (6), and (8), we obtain:

$$\dot{t} = -\frac{(1-\psi')}{\psi''}(\rho + \delta) + \frac{\phi' S'}{\psi''}\ . \tag{9}$$

The two differential equations (7) and (9), together with the first-order condition (5), determine the paths of optimal tipping and service quality over the customer's planning horizon. Because the utility function is not specified, however, the differential equations cannot be solved explicitly. Nevertheless, a qualitative characterization of the optimal solution (i.e., determining whether tipping and the quality of service increase, decrease, or stay constant over time) might be possible by representing the differential equations in a state-control (R and t) space, known as a phase diagram. This diagram is presented in Figure 1.

[Figure 1 here]

To construct the diagram, notice that we can obtain from (9) and (7) the stationary loci for t (satisfying $\dot{t} = 0$) and R (satisfying $\dot{R} = 0$), respectively:

$$(1-\psi')\,(\rho + \delta) \;-\; \phi' S' \;=\; 0 \tag{10}$$

$$t \;-\; t_n - \delta R \;=\; 0\,. \tag{11}$$

Equations (10) and (11) are plotted in Figure 1. Equation (11) implies that the $\dot{R} = 0$ locus is a positively-sloped straight line, beginning at R = 0 and $t = t_n$. The positive slope represents the idea that the higher is the customer's reputation, the more he has to tip in order to retain this reputation. This makes sense: a customer who has been very generous in the past cannot retain a reputation for being very generous if he switches to average tips, but a customer with a reputation for being an average tipper can retain this reputation by remaining average.

Totally differentiating Equation (10) and rearranging, we also find that

$$\left.\frac{\partial t}{\partial R}\right|_{\dot{t}\,=\,0} \;=\; -\,\frac{\phi''\left(S'\right)^2 \;+\; S''\phi'}{\psi''\,(\rho + \delta)} \;<\; 0\;. \tag{12}$$

It is easy to see that the slope of the $\dot{t} = 0$ locus is negative because we previously assumed that $S'(\bullet) > 0$, $\phi'(\bullet) >$, $\psi'(\bullet) \; > 0$ and $S''(\bullet) < 0$, $\phi''(\bullet) < 0$, $\psi''(\bullet) \; < 0$. Substituting R = 0 in (10) and rearranging yields

$$\psi'\,(\hat{t} - t_n) \;=\; 1 \;-\; \frac{\phi'(\tilde{S})\,S'(0)}{\rho \;+\; \delta} \quad , \tag{13}$$

where $\hat{t}$ represents the tipping level for $R = 0$ on the $\dot{t} = 0$ locus. Similarly, substituting $t = t_n$ in (10) yields

$$1 - \psi'(0) = \frac{\phi'\left[S(\hat{R})\right]S'(\hat{R})}{\rho + \delta} \quad , \tag{14}$$

where $\hat{R}$ represents the reputation level for $t = t_n$ on the $\dot{t} = 0$ locus.

To determine the directions of the streamlines in the phase diagram, we partially differentiate the motion equations (7) and (9), obtaining

$$\frac{\partial \dot{R}}{\partial t} = 1 > 0 \tag{15}$$

$$\frac{\partial \dot{t}}{\partial R} = \frac{\phi''(S')^2 + S''\phi'}{\psi''} > 0 \ . \tag{16}$$

Equation (15) indicates that in points above the $\dot{R} = 0$ locus, $\dot{R}$ is positive (i.e., R increases over time), because the derivative of $\dot{R}$ with respect to t is positive. Consequently, the horizontal arrows in the region above the $\dot{R} = 0$ locus point to the right. Similarly, equation (15) also indicates that in points below the $\dot{R} = 0$ locus, $\dot{R}$ is negative, implying that reputation decreases over time in that region. As a result, the horizontal arrows in the region below the $\dot{R} = 0$ locus point to the left.

Because the derivative of $\dot{t}$ with respect to R is positive (see Equation (16)), in points to the right of the $\dot{t} = 0$ locus, $\dot{t}$ is positive, so tips increase over time. Consequently, the vertical arrows to the right of the $\dot{t} = 0$ locus point upwards. Similarly, to the left of the $\dot{t} = 0$ locus, $\dot{t}$ is negative, so tips decrease over time, and therefore the vertical arrows in that region point downwards.

The four streamlines (starting from points A, B, C and D) are drawn in accordance with these arrowheads and they imply that the stationary combination of *R* and t (point E), in which *R* and *t* remain unchanged, is a saddle point: while there are paths converging to the stationary point, there are also paths leading away from it. Proposition 1 proves this more formally:

Proposition 1. The stationary equilibrium that satisfies equations (10) and (11) simultaneously (Point E in Figure 1) is a saddle point.

Proof. Notice that the Jacobian matrix of the system of equations describing the laws of motion, (7) and (9), evaluated at point E, is:

$$J = \begin{pmatrix} \frac{\partial \dot{R}}{\partial R} & \frac{\partial \dot{R}}{\partial t} \\ \frac{\partial \dot{t}}{\partial R} & \frac{\partial \dot{t}}{\partial t} \end{pmatrix} = \begin{pmatrix} -\delta & 1 \\ \frac{\phi''(S')^2 + S''\phi'}{\psi''} & \rho+\delta \end{pmatrix} . \tag{17}$$

The determinant of *J* is:

$$|J| = -\delta(\rho+\delta) - \frac{\phi''(S')^2 + S''\phi'}{\psi''} < 0, \tag{18}$$

the sign of which is negative. Hence the equilibrium solution is a saddle point. Q.E.D.

A key determinant of the evolution of tipping and reputation over time is their initial values. The initial value of reputation is exogenously given at *R*(0) = 0, implying that $S[R(0)] = \tilde{S}$. The initial value of the tip, $t(0)$, should be derived by explicitly solving the differential equations (7) and (9), using $R(0) = 0$. This procedure, however, is impossible under the general formulation of the utility function. Consequently, restricting the analysis to qualitative characterization of the optimal solution, any value of $t(0) \geq t_n$ could match $R(0) = 0$ as a potential starting point for an optimal path of R and t over time.

Figure 1 suggests four prototypes (denoted by the starting points A, B, C and D) of optimal trajectories of tipping and reputation over time. Because service quality is an increasing function of reputation, the direction of service quality is the same as that of the reputation. The directions of the horizontal and vertical arrows, as explained above, determine how the trajectories evolve.

Along trajectory A, tipping starts decreasing while the level of reputation starts increasing with time, and eventually tipping and reputation converge to point E. Because point E is a stationary equilibrium, once it is reached, tipping and reputation remain unchanged. Along trajectory B, tipping starts decreasing while reputation increases, but after hitting the $\dot{t} = 0$ locus, tipping changes direction and both tipping and reputation increase indefinitely over time. It is easy to see that tips and reputation also increase indefinitely in the case of $t(0) > \hat{t}$, depicted in trajectory D. Along trajectory C, tipping starts decreasing while the reputation level starts increasing with time, yet after hitting the $\dot{R} = 0$ locus, the reputation level changes direction and both tipping and reputation decrease with time. Hence, the customer ends up with zero reputation, receives the worst service quality, and tips the minimal amount, t_n.

4. Comparative Statics Results

As discussed above, tips and reputation can converge to the point E, converge to (0, t_n), or diverge (in which case both tips and reputation increase indefinitely). Of particular interest is the interior stationary equilibrium of point E, because it seems to describe best the tipping behavior of most real customers, and because this is the only equilibrium which we can analyze meaningfully by means of comparative statics. How does point E change when the parameters of the model change? Consider first a change in the reputation deterioration rate, δ. Totally differentiating Equations (10) and (11) with respect to δ and solving the two resulting equations simultaneously we obtain:

$$\frac{\partial t_E}{\partial \delta} = \frac{\delta(1-\psi') + R_E\left[\phi''(S')^2 + \phi' S''\right]}{\left[\delta(\delta+\rho)\psi'' + \phi''(S')^2 + \phi' S''\right]} \tag{19}$$

$$\frac{\partial R_E}{\partial \delta} = -\frac{(\delta+\rho)\psi'' R_E - (1-\psi')}{\left[\delta(\delta+\rho)\psi'' + \phi''(S')^2 + \phi' S''\right]} < 0 . \tag{20}$$

While $\partial t_E / \partial \delta$ has an indeterminate sign, $\partial R_E / \partial \delta$ is unambiguously negative. This implies that an increase in the deterioration rate will shift point E (through the changes in the $\dot{t} = 0$ and $\dot{R} = 0$ loci) leftwards and either upwards or downwards relative to its present location in Figure 1. That is, the equilibrium reputation level will fall, whereas the effect on equilibrium tipping cannot be determined unambiguously for the general case (i.e., without specifying more fully the utility function and the parameters of the model). Recall that a lower value of δ can represent a higher patronage frequency. Inequality (20) tells us that customers who purchase the service less often (and therefore have a higher value of δ) will have lower reputation. The reason is that their tipping behavior is not remembered well due to their infrequent visits, and therefore they have less incentive to invest in building reputation in order to improve the service they receive.

For a similar reason, we might expect to find that the tip is decreasing in δ, i.e., that frequent customers tip more. Because the expression in (19) cannot be signed, however, this is not necessarily true; for δ close enough to zero, for example, $\partial t_E / \partial \delta$ is positive, implying that frequent customers tip less. The reason why $\partial t_E / \partial \delta$ can be either positive or negative is that two opposite effects are taking place. The first effect is that a higher value of δ implies that it is less worthwhile to invest in building reputation, because reputation deteriorates more quickly when δ is higher. In other words, the returns to tipping in the form of future reputation and service quality are decreasing in δ, leading to less tipping when δ is higher. The second effect is that to reach and maintain a certain reputation level, more tipping is needed when δ is higher, because reputation deteriorates faster. The numerator of the expression in (19) determines which of the opposite effects dominates.

Next, consider a change in the minimal tip, t_n. Totally differentiating Equations (10) and (11) with respect to t_n and solving we obtain:

$$\frac{\partial t_E}{\partial t_n} = 1 \tag{21}$$

$$\frac{\partial R_E}{\partial t_n} = 0 \; . \tag{22}$$

Equation (21) suggests that tipping in the stationary equilibrium changes by exactly the same amount as the change in the minimal tip. Because the reputation change in each period depends on the difference between the tip and the minimal tip, it is intuitive to expect that equilibrium reputation is unaffected by the level of t_n, as (22) reveals.

Finally, consider a change in the customer's discount rate, ρ. Totally differentiating Equations (10) and (11) with respect to ρ and solving we obtain:

$$\frac{\partial t_E}{\partial \rho} = \frac{\delta(1-\psi')}{\left[\delta(\delta+\rho)\psi'' + \phi''(S')^2 + \phi' S''\right]} < 0 \tag{23}$$

$$\frac{\partial R_E}{\partial \rho} = \frac{(1-\psi')}{\left[\delta(\delta+\rho)\psi'' + \phi''(S')^2 + \phi' S''\right]} < 0 \tag{24}$$

It is easy to see that both (23) and (24) are negative, suggesting that when the customer becomes less patient (higher ρ), he tips less and has lower reputation in equilibrium. The intuition is simple: tipping creates a net cost today (since the psychological marginal utility from tipping is smaller than the cost of the tip), but a benefit in the future – better reputation and therefore higher service quality. The less patient the customer is, the less he wants to make sacrifices today for future benefits, therefore the less he tips and the smaller his reputation is.

5. Empirical Evidence on Tipping Behavior

An interesting issue is whether empirical evidence on tipping behavior supports the predictions of the model. Unfortunately, the existing empirical literature on tipping does not include data on reputation or time preferences of customers (the parameter ρ in the model). It should be possible to obtain information about reputation by asking customers about their past tipping behavior in a certain restaurant, or by asking waiters to evaluate the customers' reputation. It is also feasible to get a proxy for time preferences of customers by asking them about their time preferences or about how they divide their income between consumption and savings (and what types of savings they choose) and making inferences from these choices. Such empirical studies could be interesting and are provided as ideas for future research, but are beyond the scope of this article.

What can be examined in empirical studies that appeared in the literature is the correlation between patronage frequency and tips. Recall that in the model this correlation could not be signed unambiguously, and its sign depended on the specific functions and parameters. It turns out that the empirical evidence is also somewhat unclear about the relationship between patronage frequency and tips. Bodvarsson and Gibson (1997) studied six restaurants and a coffee shop and found in all of them that regular customers (those who patronized the restaurant at least once a month) tip more than non-regular patrons, but only in the coffee shop and one of the restaurants the difference was statistically significant. On average, regular patrons tipped 1.05 percents more (of the bill size) than others. Conlin, Lynn, and O'Donoghue (2003) also find a positive relationship between patronage frequency and tips: the coefficient of the independent variable "Times tipper frequents this particular restaurant (monthly)" in a regression that explains percent tip is 0.187 and is statistically significant at the 5% level. However, this effect is small in magnitude: someone who dines at the restaurant five times each month tips less than 1% (of the bill) above the tip of a one-time customer. Lynn and Grassman (1990) and Lynn and McCall (2000b) also found significant and positive correlation between patronage frequency and tip size.

However, as Azar (2006) argues, the positive correlation between patronage frequency and tip size might be the result of an omitted variable, namely the tipper's income. Higher-income customers generally eat at restaurants more often, and they might tip more because of their higher income. As a result, if the tipper's income is not controlled for in the regression (and the studies mentioned above do not include income as an independent variable), a positive correlation between patronage frequency and tips might be only a result of the income effect on tips.

This omitted variable problem can be overcome by hypothetical surveys, in which people are asked about how they would tip in a hypothetical scenario. If some people are asked to consider tipping in a restaurant they visit often while others are asked about a restaurant which they do not visit repeatedly, we can compare the responses in the two groups and the income problem is not present because the assignment of subjects to treatments is random (and therefore those who are asked to imagine a restaurant that they visit frequently are not richer than others). Studies that used this approach either found that the average tips in the two groups were the same (Kahneman, Knetsch and Thaler 1986), or obtained mixed results about the correlation between patronage frequency and tips (Bodvarsson and Gibson 1999; Azar 2006).

Another alternative to overcome the problem of the correlation between income and patronage frequency is to ask subjects about their income and include it in the analysis. Parrett (2006) did so and found in some regressions a positive relationship between patronage frequency and tips, and in other regressions a non-linear pattern in which customers with medium dining frequency tip more than customers with both low- and high patronage frequency. All these results, however, were not statistically significant, and moreover, the coefficients were also small in their magnitude – explaining less than one percent (of the bill size) in regressions of percent tip, and less than 30 cents in regressions of dollar tip.

6. Conclusion

We presented an optimal-control model of tipping in which tipping behavior creates reputation that affects service quality in the future; in particular, tipping more today improves future service. Because of future service motivations, and because tipping provides psychological utility, the customer has an incentive to tip generously. On the other hand, tipping is also costly. We examined the optimal path of tipping, and found that tipping and reputation can evolve in four path prototypes: (A) Converging to an interior stationary equilibrium with tips above the minimal level and positive reputation; (B) Tipping decreases first and then increases indefinitely, while reputation increases indefinitely from the beginning; (C) Tipping converges to the minimal tip and reputation converges to zero; and (D) Tipping and reputation increase indefinitely from the beginning.

We then analyzed the comparative statics of the interior stationary equilibrium. When the reputation erodes more quickly (which corresponds to lower patronage frequency), reputation in equilibrium is lower. Interestingly, however, tips are not necessarily lower. Increasing the minimal tip raises equilibrium tips by the exact same increase, and does not change equilibrium reputation. Finally, a more patient customer leaves higher tips and reaches a higher level of reputation in equilibrium.

An interesting question is whether customers can overcome the need to build reputation by tipping upfront, before service is provided, in accordance with the suggestions made by Ruffle (1999) and Brenner (2001) that were discussed above (for a discussion of tipping in advance, see also Azar 2007b). Indeed, in the early history of tipping, tips were often given before service was provided (Azar 2004c). While upfront tipping does exist in certain occupations, waiters and taxi drivers (and many other service providers) are not tipped in advance. Why do restaurant customers and taxi passengers not tip in advance?

There seem to be several main reasons for this. First, when there is a strong social norm of tipping after the service is provided, such as in restaurants and taxis, people would probably feel uncomfortable and embarrassed if they tipped before the service was provided. Second, the social norm in restaurants and taxis is to tip a certain percentage of the bill (in the U.S. it is about 15%-20%, see Post 1997). The customer therefore needs to know the bill amount before choosing the tip, and the bill is unknown before the service has been provided. Finally, tipping in advance undermines the major roles of tipping. Many customers tip because they want to show their gratitude for the service they received (Azar 2006) – but how can someone feel grateful for a service he did not receive yet and does not know whether it would be good or bad? In addition, one of the main justifications for having a social norm of tipping is that it allows the customer to monitor the worker and to give him incentives to provide good service.[7] But if tips are given in advance, they no longer depend on the quality of service, and therefore they cannot fulfill these monitoring and incentives roles.

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[7] See Azar (2005b) for an empirical study that examines whether tipping was created in these occupations in which the customer has the greatest advantage in monitoring the worker compared to the firm's management, and see Azar (2007c) for a study that examines whether people tip because of future service considerations. Interestingly, even though tips in restaurants are given before the service is provided, service quality is generally high while the incentives for good service that customers provide in their tipping behavior are relatively small (Azar 2007d).

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Figure 1: Evolution of Tipping and Reputation