Book Errata for Foundations of Behavioral Economic Analysis, OUP, 2016.

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Abstract

This file contains the book errata for Foundations of Behavioral Economic Analysis (FBEA). I shall strive to keep updating this file and put the updated file on my website from time to time. The IMPORTANT NEWS is that we are splitting FBEA into 7 separate volumes. These new volumes will incorporate all these corrections. However, they thoroughly clarify, and edit further the material in FBEA (these edits and clarifications are not present in this Errata file), and bring the material up to date in a separate commentary at the end of each volume as a guide to further reading. There is also the addition of many new and exciting topics that were missing in FBEA (such as machine learning, complexity, Kantian equilibrium, relation between social norms and social preferences,...). The first four volumes have been published, Volumes 5 and 6 to appear in December 2019, and Volume 7 to appear around March 2020. I believe that the new volumes represent significant value added over FBEA and are a must-have for those with an interest in this subject matter.

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1 Corrections to the Book Introduction

Page 10, Section 3, line 4, replace "Richard Chamerlain" by "Edward H. Chamberlin"

Page 28, rewrite footnote 20 as: "For readers who are itching for more information at this stage, before they get to Chapter 2, $\pi_n = w(p_n)$ and $\pi_i = w\left(\Sigma_{j=i}^n p_j\right) - w\left(\Sigma_{j=i+1}^n p_j\right)$ for $i = 1, 2, \ldots, n-1$."

Page 51, 9 lines up from the bottom, "Figure 8" should be "Figure 7".

Page 31, second paragraph, last line: replace "small samples (see Section 5.5 below)" with "small samples from memory/experience (see Section 5.5 below)"

Page 49, para 4, last line: replace "lowest price" with "lowest quality".

Page 61, Question 21, first line: Replace "larger" by "smaller".

2 Corrections to Part 1

2.1 Corrections to Chapter 1

Page 84: First line in Section 1.2, change $x_1 \leq x_2 \leq ... \leq x_n$ to $x_1 < x_2 < ... < x_n$.

First and second lines below Proposition 1.3: Proposition 1.18 in these two lines should be Proposition 1.3.

Page 86, Proposition 1.1c, delete "for all $p \in [0,1]$,"

Page 91, one line before (1.10), replace "lotteries" by "Savage acts".

Page 94, first line below (1.17), missing $\mathbb{R}$ (it should read $a, b \in \mathbb{R}$).

Page 95, equation (1.21) delete ; $i = 1, 2$.

Page 96, Example 1.2. Midway through the page the equation following the line "Dividing both sides by 4, we get": U should be u.

Definition 1.14, page 97, replace $\mu \in [0,1]$ by $\mu \in (0,1)$ and replace $z < Z$ by $0 < z < Z$. Then we do not need the subsequent condition $\mu > 0$.

Page 98, Definition 1.15, first line, replace $\mu \in [0,1]$ by $\mu \in (0,1)$.

Page 99, Equation (1.34), the last term should be $b_4 = (1 - \mu p, \mu p)$ instead of $b_4 = (1 - \mu P, \mu P)$.

Page 99, last paragraph, third line, "lottery" should be "lotteries".

Page 101, four lines above Section 1.5.3: Replace "...and it is able to explain..." by "is a necessary condition to explain..."

Page 104, Section 1.5.4, second para, line 2, In Lottery L_1, the last semicolon should be a comma.

2.2 Corrections to Chapter 2

Page 152, 3rd paragraph in Section 2.7, replace $r \in X^m$ by $r \in F$.

Page 169: Two lines above (2.97) should be: "Let $\hat{e}_-$ be the optimal effort level..."

Page 115, Midway through the page, last line of the paragraph: Replace Part 4 with Part 3.

Page 123: There is an extra right bracket in the second line of Example 2.6(b).

Page 129: Second line. Definition 2.13 should be Definition 1.13.

Page 136, Example 2.13: Full stop missing at the end of the line just after "losses"

Page 148, Section 2.6.1, para 3, lines 2 and 3: Should be $y_i > 0$ and $y_i < 0$. The last sentence in this para 3 should read: Since we have assumed that X is the set of monetary outcomes and the reference point is 0, $\succeq$ corresponds in a natural way with $\geq$.

Page 149, Delete last line of the proof of Lemma 2.1 (The second inequality...it.)

Page 149, 3rd line up from the bottom: Change the $>$ sign to a $=$ sign.

Page 160 first line after equation (2.69): Delete the redundant "2.22".

Page 165, middle of the page, case C3, all inequalities should be strict ($e_H < e_L < e$). Same correction on page 166, about 2/3 of the way down.

Page 167, line 3, replace (2.90) by (2.92).

Page 175, second line, replace "postive and negative" with "negative and positive".

Page 182, two lines above Figure 2.15, replace "maximizers (Type I)" with "maximizers (Type II)"

Page 184, Section 2.10.3 at the end of the line, after the word "salience" insert "of".

Page 185, fourth line of Example 2.23: The lottery $L_2(z)$ should be

$$L_2(z) = (2400, 0.34; z, 0.66).$$

Page 187, 3 lines above equation (2.120) replace M_i by $M_i \subset \overline{C}$.

Page 193, 3rd para, 3rd line, replace "Definition 2.3.4" by "Example 2.6"

Page 193, Section 2.11.2, end of line 2 replace "low probability anomalies" by "anomalies arising from low probability events"

Page 201, 1 line above equation (2.138) delete the word "interior".

Page 202, Caption for FIgure 2.19, line 3: Replace (0.8, 1) and (0.4, 0.5) by (0.8, 1) versus (0.4, 0.5).

Page 203, first sentence after equation (2.143) should be: "Let us compare average consumption under EU and RDU (delay-discounting in each case), i.e., we compare (2.138) and (2.143)."

Page 205, first line, replace "$w(p) \approx \widehat{w}(p) = a + bp$." by "$w(p) \approx \widehat{w}(p) = a + bp$, $a > 0$, $b > 0$."

Page 206, first line after equation (2.154): Replace "(2.154) allows us to" by "We now wish to"

Page 209, last line, replace $\alpha\beta = 1$ by $\alpha = \beta = 1$.

2.3 Corrections to Chapter 3

Page 218, 5 lines up from the bottom, delete the last word in the sentence "respectively".

Page 220, two lines below equation (3.1), replace "value" by "outcome"

Page 221, 8th line in 2nd paragraph, replace "older and more" by "younger or less"

Page 221, para 4, line 1: Replace "to" with "of".

Page 223, first sentence after Definition 3.62 should be: "We use the value function under PT (Definition 2.34) to calculate the relevant expressions for RWTA and RWTP."

Page 225: Footnote 12: Replace "Good B" with "Item B".

Page 228, footnote 16, line 3: insert "we" before "consider".

Page 235, footnote 22, second line, replace "Chapter 1.4" by "Chapter 4".

Page 237, line 4, replace "dropped" by "reduced".

Page 239, first line after (3.13): replace "two identical prospects" by "two independent and identical prospects"

Page 247, last but one paragraph, line 3 replace $p \in [0.01, 0.05]$ by $p \in [0.01, 0.05]$.

Page 249, equation (3.31), replace $V(0)$ by $V(0, 1)$.

Page 252, one line before equation (3.44) "domain of losses" should be "domain of gains".

Page 256, last line, replace β_2 by β_1.

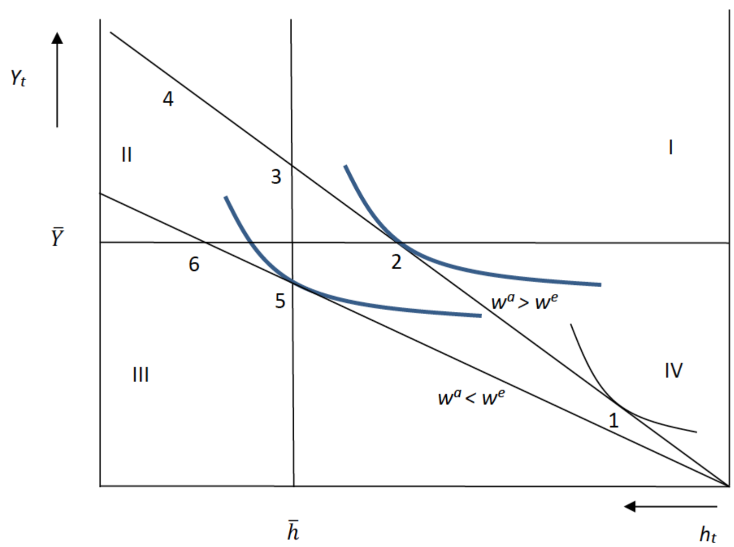

Figure 1: Restating Figure 3.8, p. 262 in Foundations. An illustration of the equilibrium in the Crawford–Meng (2011) model. Source: Crawford and Meng (2011) with permission from the American Economic Association.

Page 258, Table 3.3, first row, set $\lambda = 1$ in the entire first row.

Page 258, 10 lines up from the bottom, "Remark 10" should be "Remark 3.10".

Page 260, two lines above (3.54) replace w^a by w^e.

Page 260, Define the domain of gains for incomes and hours as $Y \geq \overline{Y}$, $h \leq \overline{h}$, respectively (and not $Y > \overline{Y}, h < \overline{h}$). Make the same correction in Table 3.4 on Page 261.

Page 261, last paragraph, lines 2 and 5, replace "northeast" by "northwest".

Page 262, first paragraph, replace "PTT" by "PT", the standard abbreviation for prospect theory. Make the same correction in lines 2,3 in the next paragraph.

Page 262. For a clearer version of Figure 3.8 in the book see Figure 1 in this file.

Page 276, first paragraph, last but one sentence should be: "Thus, for $\phi \geq 0$ we have $\lambda \geq \lambda_c$ and $\phi \frac{\partial \Gamma}{\partial \phi} = 0$ implies $\frac{\partial \Gamma}{\partial \phi} = -\Delta w_M = 0$, or $\Delta w_M = 0$."

Page 278, in the middle of the page, replace "$(\lambda > 1)$" by "$(\lambda > 0)$"; this is because for (2.77), the weaker restriction $\lambda > 0$ is sufficient to ensure loss aversion. Just one line below this, replace $1 < k \leq n$ by $1 \leq k \leq n$.

Page 280. Last line, equation (3.86) delete "8".

2.4 Corrections to Chapter 4

In the Introduction to Part 2, Page 339, middle of second paragraph, replace "less unfortunate" by "less fortunate".

Page 290, replace the last term in the lottery in the middle of the page from $(1 - \alpha) p_m$ to $(1 - \alpha) q_m$.

Page 293, line 4, replace "$p = 0$ or $p = 2/3$" by "for any $p \in [0, 2/3]$".

Page 294, immediately after equation (4.9) it should read: "where $w(p)$ is a probability weighting function and u is a utility function such that $u(0) = 0$."

Page 298, 8 lines above section 4.3.6, replace "$x \in X$, the set of outcomes" by "x, where x is an act"

Page 37, caption to Figure 4.1, the source should be Abdellaoui, Baillon et al. (2011).

Page 313, Problem 27(a) should be: Show under RDU, with the Prelec function, and $p \to 0$, optimal $C^* = 0$ or $C^* = L$. Problem 27(c) should be: What is your conjecture of insurance behavior under composite prospect theory (CPT)? Problem 27(d) last line should be: Conjecture if CPT can account for these conflicting findings?.

Page 315, Problem 32: 4 lines above equation (4.27) replace "if a head" by "if the first heads". In the last sentence of Prolem 32, delete the word "also".

3 Corrections to Part 2

Page 339, para 2, line 5, replace "unfortunate" by "fortunate".

Page 342, footnote 6 should read: A related concept from biology is that of *reciprocal altruism*. This involves a tendency to reward others in response to their kind behavior, when such net rewards may be expected to be reiprocated in the long-term by others. See, for instance, Axelrod and Hamilton (1981) and Trivers (1971).

3.1 Corrections to Chapter 6

Page 398, line 2 of introduction, replace "social preferences" by "other-regarding preferences".

Page 400, footnote 2, replace "accepts" by "rejects".

Page 403, in Table 6.1, replace Eckel and Gintis (2009) by Eckel and Gintis (2010).

Page 415, Remark 6.1, line 7, replace $p_s < 1$ by $p_l < 1$.

Page 415, just below the only table on the page, replace the first two sentences by the following: "Below income $y_3 = 50$, distribution Q moves some richer individuals to a poorer income level and a fraction 2ε of individuals with income $y_3 = 50$ are distributed equally between the higher income levels of 75 and 100. Using (6.15), a simple calculation shows that an individual with income $y_3 = 50$ prefers the distribution P to the distribution Q."

Page 422: (1) one line prior to (6.33): Replace (10.18) by (6.30). (2) one line after (6.33): Replace (10.22) by (6.31).

Page 427, 2 lines below Definition 6.13: Replace U by U_i.

Page 445, middle of the page, sentence starting with "Hence, when....": Replace "x_i for player i, expressed in terms of x_j" with "x_A for player A, expressed in terms of x_B".

3.2 Corrections to Chapter 8

In the proof to part (iv) replace the start of the sentence "Substituting the wage in (iii) contracts on" with "Substituting the optimal wage contract in (iii) into"

Page 485, first line of the proof to Proposition 8.24(iv), replace $c\frac{p_1}{\Delta p} > c$ by $c\frac{p_0}{\Delta p} > c$.

Page 492: Middle of the page, the correct IC and IR conditions (missing costs in the original) are:

$$\overline{u}(a_1) - \overline{u}(a_0) + r\overline{u}(a_1)\left(\overline{\pi}(a_1) - \overline{\pi}(a_0)\right) \geq \Delta c \quad \text{(IC)}$$
$$\overline{u}(a_1) + r\overline{u}(a_1)\overline{\pi}(a_1) - c_1 \geq 0. \quad \text{(IR)}$$

Page 497, 4 lines up from the bottom, replace "the agent and induce" by "the principal and induce."

Page 512, 4 lines from the bottom, replace "in Chapter 12" by "in Chapter 5".

Page 528, line 7, prefix "gross" to the first word on the line "payoffs"

Page 556, line 2, replace "enhaced" with "correlated with".

Page 559, footnote 31, first line, replace "are" with "is".

Page 560, second paragraph towards the end has a typo in the use of brackets. It should read: "When incentives are delayed in the experiments (e.g. students are paid a month later), then the beneficial effects of incentives are substantially curtailed. In actual practice the rewards to education, such as jobs, salaries, and perks (which are the corresponding incentives in the real world) follow with substantial delay, suggesting that there could be underinvestment in education."

4 Corrections to Part 3

Page 584, line 8, replace "reduces" by "increases"

4.1 Corrections to Chapter 9

In equations (9.1), (9.2), (9.7) (pages 587-89) there is a missing boldface: Replace $\mathbf{c}_0 \in C$ by $\mathbf{c}_0 \in \mathbf{C}$.

Here is a clearer statement of the brief paragraph before equation (9.17) on page 591: The optimal plan, so far, was generated from the perspective of period 0. Now suppose that we allow the individual to reoptimize at some future date $\tau > 0$ but keeping t fixed and letting $t > \tau$. The analogue of condition (9.16) is given by

Page 592, sentence before equation (9.27) missing "and": Should be "if and only if"

Page 593, first paragraph: Replace $Z \subset \mathbb{R}$ by Z and $\Gamma \subset \mathbb{R}_+$ by Γ.

4.2 Corrections to Chapter 10

Page 612, Poposition 10.6, replace "discount factor" in first line by "discount function".

Page 625, in the text below Definition 10.6, the second sentence is slightly more clearer if written like this: Yet, starting from indifference at $\overline{p}$, a fall in p below $\overline{p}$ switches preferences towards the lottery with the higher outcome, but an increase in p above $\overline{p}$ switches preferences to the lottery with the lower outcome.

4.3 Corrections to Chapter 11

Page 648, Equation (11.3), the last inequality should be reversed: (b) $\eta < u_1(0, \theta)$.

Page 659, just the last sentence before equation (11.37) should read: "The budget constraint for period $t = 0$ is $c_0 + s_0 = y_0$ and for subsequent periods it is"

Page 662, line 2, replace $\omega_{j=t}$ by ω_t.

Lemma 11.2 on Page 665 is better stated as follows:

Lemma 11.2: Consider the maximization problem

$$\underset{\langle c_1, c_2 \rangle}{Max}\ u(c_1) + \lambda u(c_2),\ \lambda \in (0, 1)\,,$$

subject to $c_1 + s = W$ and $c_2 = Rs$, where $R > 0$ and $W > 0$. The intertemporal budget constraint is

$$c_1 + \frac{1}{R} c_2 = W.$$

Under CRRA utility, the optimal solution is $c_1^* = \omega(R, \lambda)W$, where $\omega(R, \lambda) \in (0, 1)$ and $\frac{\partial \omega}{\partial \lambda} < 0$.

Page 667, equation (11.74), second term: Replace R by R^2. [i.e., it should be $\beta \delta R^2 (1 - \omega_2) [u'(c_3^w) - u'(c_3^r)]$].

Page 667, second sentence below equation (11.74) can now benefit from the restated Lemma 11.2 and rewritten as: "Using a simple extension of Lemma 11.2, the first period savings choice of self 1, $s_1 \in (0, y)$."

Page 675, three lines from the bottom: Replace v with $\mathbf{v}$. Make the same correction in the first line of page 676.

Page 685, two lines below (11.132), replace "she will" by "he would prefer to" [this is to ensure that we remain gender consistent].

Page 685: Lemma 11.7, second line, it is slightly clearer to write "forecasted and the desired consumption probabilities of self 0" rather than "forecasted and the actual consumption probabilities".

Page 686, inequality (11.136), the RHS: Replace $\overline{u}$ by $\beta \delta \overline{u}$.

5 Corrections for Part 4

5.1 Corrections to Chapter 12

Page 725, 3 lines from the bottom; replace "increases" with "decreases".

Page 736, Example 12.2. 4th sentence, second line should be: For player 2, $x_{2t} = B$ for all $1 \leq t \leq 9$ and $x_{210} = A$.

Page 737, para 3, line 4: replace all-A by all-B.

Replace "an MSE" with "a MSE" throughout this chapter. We normally say "a mixed strategy equilibrium" in economics, however, the proofreader inserted "an mixed strategy equilibrium" throughout and I failed to notice this.

Page 756: Second sentence should be: "The p-values are shown in the table for the row player (pursuer), the column player (evader), and for joint play."

Page 776: 8-9 lines from the bottom: Omit "prior to paying the fee".

Page 777, third para from the bottom, second sentence should be: "Possible-loss avoidance occurs when one shuns the play of strategy R in game M, while certain-loss avoidance occurs when one shuns the play of strategy S in the game L."

Page 791, point 3 in the middle of the page is better stated as follows: In the "partial information condition," Games 1 and 3 should have the same Nash bargaining solution and so should Games 2 and 4: Property 4 requires mutual knowledge of utility functions. The full information condition reveals the mutual monetary payoffs. However, in the partial information condition, players only know their own monetary payoffs. However, each player observes the bargaining split of the lottery tickets, and so observes the probability p that the other player has of winning the prize. This information is sufficient to construct the utility function of the other player (recall, $u(x_2) = p$). Thus, the expectation is that Property 4 (mutual knowledge of utility functions) applies fully only to the partial information condition.

Page 793, penultimate line on the page, replace $(x, c - x)$ by $(c - x, x)$.

Page 8.15, caption to the figure: remove the word "over".

Page 808, first line after equation (12.21): replace Figure 12.35 by Figure 12.34.

Page 829, last line, replace the first "period 4" in the line with "period 5."

Page 830, line 5 delete the word "weak"

Page 833, Table 12.29, first row, replace S_L^*, S_H^* by s_L^*, s_H^*. Make the same correction in Table 12.30 on page 834.

Page 834, footnote 89: Remove the subscript L on s_L.

Page 845, line 4 replace (D, D) with (D,R).

5.2 Corrections to Chapter 13

Page 816, line 4: Change the following text "...fail the 'direct test' of being in accord with the..." with the following edited text "...fail the 'direct test' and are not in accord with the..."

Page 886, third line, the correct sentence should be "As x increases the QRE changes, but there is no change in π_T in a Nash equilibrium." [Notice the addition of "in π_T"].

Page 905, Figure 13.10, middle sub-figure, the 2,2th entry which is 100, 100 should be replaced by 101, 100.

Page 908, Remark 13.2 is more accurately worded thus: The coordination rate, $\rho(a)$, is maximized at $a = 1$. The maximum coordination rate is given by $\rho_{\max} = 0.5$, and, $\lim_{a\to\infty} \rho(a) = 0$. The payoff from each pure strategy in the mixed strategy profile is $a/(1 + a)$.

Page 919, First line after Proposition 13.33: replace (a) by (i).

Page 920, Proposition 13.34, line 3: Replace $\hat{x}_i$ by $\hat{x}_j$.

Page 937, Figure 13.21, Panel B, when player 1 plays U, his payoff should be -1000, not 1000 (In the text on p. 938, it says correctly that both players get the inefficient payoff of -1000 each).

Page 942, equation (13.55): Replace $\tilde{k}_{iki}$ by $\tilde{k}_{ik}$.

Page 943: Paragraph starting on line 3 is too cryptic in some places and there is a typo. Here is a better version: "A problem in testing the theory is that λ_i is unobservable. If $b_{ij}^1 + b_{ik}^1 - 20 = 20$ and $s_i = 0$, then even with the most optimistic beliefs about others, i.e., maximum contributions from others, one still chooses $s_i = 0$. Clearly λ_i must be too low in this case. Hence, Dufwenberg et al. (2011) test a weaker prediction of the theory, namely, that either $b_{ij}^1 + b_{ik}^1 = 40$ and $s_i = 0$ or there is positive correlation between s_i and $b_{ij}^1 + b_{ik}^1$. They consider a 2×2 factorial design that varies the "*label frame*" and the "*valence frame*." Variations in the label frame are achieved through the treatments: Neutral and Community. In the Neutral treatment, the instructions speak of "the experiment," while in the Community treatment, the instructions speak of "the community experiment." The valence frame is implemented by the Give and Take treatments. The Give treatment is as described in the public goods experiment above. In the Take treatment, subjects are endowed with the resources and then allowed to take from it (so s_i has the interpretation of the amount that player i withdraws from the common resource). The monetary payoffs and the equilibria in each case are identical."

Page 950, the only unnumbered equation towards the top of the page, third line, first column, should be: $u_1(\tilde{t}) = y - \tilde{t} + (1-\gamma)\left(b_1^2 - \tilde{t}\right)$.

Page 951 paragraph starting on line 3, replace the first two sentences with this clearer version: "The parameter γ_i is unobservable, but $\frac{b_{iji}^2+b_{iki}^2}{2}$ is observable. If $s_i = 0$ and $\frac{b_{iji}^2+b_{iki}^2}{2} > 0$, it implies that $\gamma_i < \frac{1}{2}$; such subjects can be isolated from the data. For the remaining subjects, Dufwenberg et al. (2011) test the weaker hypothesis that the correlation between s_i and $\frac{b_{iji}^2+b_{iki}^2}{2}$ is positive." Also replace the very last sentence in this same paragraph by: The filled-in circles represent the case $s_i = 0$, $\frac{b_{iji}^2+b_{iki}^2}{2} > 0$ and $\gamma_i < \frac{1}{2}$.

Page 953, line 16 replace the sentence starting with "Clearly..." by : "If the players have self-regarding preferences and lack emotions such as guilt (as reflected in the payoffs in panel A), then such communication will be ineffective."

Page 956, third paragraph, 3 sentences beginning on line 15 with "Player 2...", replace by: "We assume a distribution of beliefs in the spirit of the Köszegi–Rabin framework (see Volume 1 of the book). Player 2 has the first order belief, b_2^1, about the transfer to him. The second order belief of player 1 about the belief, b_2^1, is given by, b_1^2."

Page 957, first line after equation (13.76): Replace $t \times (\theta)$ by $t^*(\theta)$.

Page 957, first line of Proposition 13.39: Replace $t \times (\theta)$ by $t^*(\theta)$.

Paage 957, first sentence after equation (13.78) should be: Since θ is assumed to be the median of the distribution F_2^1, $F_1^2\,(t^* = \theta \mid \theta) = \frac{1}{2}$.

Page 968, Definition 13.23 has some notational typos. It should read: (Analogy-based expectations equilibrium, ABEE) : A strategy profile (σ_r, σ_c) is an analogy-based expectations equilibrium (ABEE), given the analogy partitions A_r, A_c, if for all $G \in \mathbf{G}$ and all s_j^* in the support of $\sigma_j(G)$, $j = r, c$ we have

$$s_j^* \in \arg\max \sum_{s_i \in S_i} \overline{\sigma}_i(s_i \mid G) u_j\left(s_j, s_i \mid G\right),\ i \neq j,\ i = r, c,\ s_j \in S_j,$$

and $\overline{\sigma}_i$ is given in (13.91).

Page 983, Case 3, there are typos. The correct social projection function should be:

$$\begin{cases} P_{12}\left(C|C\right) = 1, P_{12}\left(D|C\right) = 0; P_{12}\left(D|D\right) = 0, P_{12}\left(C|D\right) = 1, \\ P_{21}\left(C|C\right) = 1, P_{21}\left(D|C\right) = 0; P_{21}\left(C|D\right) = 1, P_{21}\left(D|D\right) = 0. \end{cases}$$

The text immediately following the only equation on the page can be written a little more clearly with player identities: "denote the logit probability that player i plays S, conditional on a belief that the opponent plays S with probability q and $\mu = \mu_0$ is the error rate with which player i makes choices. q represents a player's *first order beliefs* about the other player. So we can recursively define higher order beliefs as follows.

1. ρ^0 represents player i's choice probability ($\rho^0 \equiv \pi_{iS}(q \mid \mu_0)$).

2. ρ^1 represents player i's first order beliefs about the strategy choice of the opponent ($\rho^1 \equiv q$).

3. ρ^2 represents player j's second order beliefs. These are the beliefs of player j about the first order beliefs of player i, ρ^1. And so on ..."

6 Corrections to Part 5

6.1 Corrections to Chapter 14

Page 1039, 7 lines up from the bottom, replace the expression in brackets with (begin by cooperating, and then for any $t > 1$ mimic the period $t-1$ strategy of the opponent, cooperate or defect).

Page 1050, equation (14.30), remove the subscript i on π in the square brackets.

Page 1058, second paragraph, first sentence, replace "asymptotic solution" by "stable steady state".

Page 1063, Definition 14.7, the first condition should be: (i) Σ is a non-empty compact and convex subset of an m dimensional Euclidean space.

Page 1072, part (c) line 2: The condition should be $f' > 0$.

Page 1075, 5 lines up from the bottom replace "across groups" with "between members of the same group".

Page 1077, replace the first paragraph with this text: "Conditional on all others playing their part of the tit-for-tat strategy, if an individual (i) choose the strategy A every period then he gets $(b-c)$ every period, and (ii) if he deviates and chooses the strategy B every period, then he gets b this period, but then zero thereafter, in every period. Thus, playing A is strictly preferred to B if"

6.2 Corrections to Chapter 15

Page 1100, equation 15.8 has the correct partial derivatives but there is an error. Here is a clearer version, starting two sentences previous to equation (15.8):

To demonstrate the third feature, the power law of practice, suppose that s_{ij} is the action played at time $t-1$. Then substituting (15.2) in (15.3), we get $p_t(s_{ij}) = \frac{q_{t-1}(s_{ij})+R(\pi_i(s_{ij}))}{q_{t-1}(s_{ij})+R(\pi_i(s_{ij}))+\sum_{j\neq i} q_{t-1}(s_{ij})}$. Differentiating $p_t(s_{ij})$ with respect to the reinforcement, $R(\pi_i(s_{ij}))$, we get

$$\frac{dp_t(s_{ij})}{d(R(\pi_i(s_{ij})))} = \frac{\sum_{j\neq i} q_{t-1}(s_{ij})}{Q_{it}^2} > 0; \frac{d}{dt}\left(\frac{dp_t(s_{ij})}{R(\pi_i(s_{ij}))}\right) = \frac{-\left(\sum_{j\neq i} q_{t-1}(s_{ij})\right)}{Q_{it}^4}\frac{d}{dt}(Q_{it}^2) < 0.$$

Page 1101, Equation (15.11), second row: Replace $uq_t(s_{ik})$ by $u(s_{ik})$.

Page 1107, two lines above equation (15.18) should be $\sum_{k=1}^{n_j} w_0^i(s_{jk}) > 0$ (notice subscript t replaced by 0).

Pae 1108, equation (15.25) should (for consistency with earlier use) be $p_t^i(s_{ik} \mid \sigma_{-i}) = \frac{e^{\lambda_i \pi_i(s_{ik},\sigma_{-i})}}{\sum_{j=1}^{n_i} e^{\lambda_i \pi_i\left(s_{ij},\sigma_{-i}\right)}}$.

Page 1109, Proof of Proposition 15.23. Sentences 2 and 3 should be: "Let there is some $s_1^* \in S_1$ in the support of σ_1^* and some $\hat{s} \in S_1$ that is not in the support of σ_1^* such that"

Page 1110, first line below equation (15.28), remove comma after "Using"

Page 1117, one line above hypothesis H1, replace $\frac{\partial p_j}{\partial \delta_j} > 0$ by $\frac{\partial p_j}{\partial \delta_j}\left(\frac{\partial p_j}{\partial (q-q^*)}\right) >$ 0

Page 1129, equation (15.52) replace $i \in N$ by $i = 1, ..., n$

7 Corrections of Chapter 16

Page 1169, Proof of Proposition 16.29, lines 3/4: Replace "A single player mutation to strategy A will not work" WITH "A single player mutation to strategy B will not work".

Page 1180, section 16.4.3, second para, line 4: Delete "s_1 or s_2".

Page 1201, section title in captials in the middle of the page: replace Young (1993A) by Young (1993a)

Page 1207, exercise 12, last line of equation (5.E1), replace $\dot{g}$ by $\dot{e}$.

8 Corrections to Part 6

8.1 Corrections to Chapter 17

Page 1245, Example 17.2, The third and fourth sentences should be: "The model requires us to put numerical values on these psychological states that are real numbers, for instance, $h = 1, e = 2, d = 3$. Then we have $X = X_1 \times X_2 = \{(h, e), (h, d)\} = \{(1, 2), (1, 3)\}$."

Page 1253, second sentence: For instance, in (17.44), (17.46), if $\alpha \neq 0$, then $\widetilde{u}(c, n \mid h) \neq u(c, n)$ and $\widetilde{u}(c, h \mid n) \neq u(c, h)$.

Page 1253, Section 17.6.2, first paragraph, second sentence onwards should be: "For pedagogical simplicity, there is no uncertainty, the discount factor $\delta = 1$, the interest rate is zero, and there is a single consumption good. The actual instantaneous utility of the consumer at time t is given by $u(c_t, s_t)$, where $c_t \geq 0$ is consumption and $s_t \geq 0$ is the state of the world at time t. Preferences are of the habit formation type, i.e.,"

Page 1254, the two lines following equation (17.55) should be:

and the intertemporal budget constraint, under the assumption of zero interest rate, is

$$\sum_{\tau=1}^{\tau=T} c_\tau = Y. \tag{17.56}$$

Page 1254, second paragraph after equation (17.56) should be:

We derive below the closed-form solution for an illustrative two-period model, $T = 2$, and assuming log preferences

$$v(c_t - s_t) = \ln(\theta + c_t - s_t);\ \theta \geq 0.$$

Assume that, for all t, $\theta + c_t - s_t > 0$, so we have a well-defined utility function with $v' > 0, v'' < 0$.

Page 1255, Prior to Proposition 17.9, there is a missing sentence:

The analogous result when there are T time periods is given in Proposition 17.9 below.

Page 1255, second and third sentences after equation (17.61) should be: But we know from Proposition 17.61 that the condition $\frac{\widetilde{Y}}{2} > s_1$ ensures that $c_1^u > s_1$, and $\frac{\widetilde{Y}}{2} > s_1 \Leftrightarrow Y > 2s_1 - \theta$. Hence, if $\frac{\widetilde{Y}}{2} > s_1$ (so $c_1^u > s_1$), then $\frac{\partial c_1}{\partial \alpha} > 0$.

Page 1256, Section 17.6.3, line 4, replace $\delta = 0$ by $\delta = 1$.

Page 1263: 3 lines below equation (17.74), replace (17.73) by (17.74).

Page 1264: To keep the notation consistent with the previous section, the last paragraph on the page (just prior to (17.78)) should be worded as follows:

Let the set of outcomes be C, let ΔC be the set of probability distributions over C, and let Z be the set of nonempty compact subsets of ΔC. Suppose there are two time periods and there is a long-lived planner (say, the cognitive system) and a short-lived myopic doer (say, the emotional system) in each period. The doer only cares about temptation utility, $v : \Delta C \to \mathbb{R}$, while the planner cares about the sum of commitment utility, $u : \Delta C \to \mathbb{R}$, and temptation utility, i.e., $u + v$. As in the GP model, the individual chooses menus, M, from the set $Z \subset \Delta C$. Once a menu is chosen in period 1, there are two possibilities for the second period choice of an outcome in M, given by

Page 1267, Section 17.8.2, first line: Replace "cost control" by "costly control".

Page 1281, first 3 sentences should be written as:

Figure 17.10 shows the relation between mean life satisfaction from the Gallup World Poll and the log of per capita GDP for 2003 (x-axis). Three curves are shown. The two outer curves are for two different age groups (the upper curve is for ages 15-25 and the lower for 60 plus) and the middle curve is the average across all age groups. The sizes of the circles represent the associated country sizes. The relation between log of per capita income and mean life satisfaction is approximately linear.

8.2 Chapter 18

Page 1303, line 3, replace δ by $1 - \delta$.

Page 1317, first line after equation (18.80): Replace "self 1" by "self 2".

Page 1322, Question 3, line immediately above the second equation: Replace "period t" by "period $t + 1$".

Page 1323. First Line. Should be: t, and γ, ϕ.

9 Corrections to Part 7

9.1 Corrections to Chapter 19

1. Page 1352, point 1b, the first sentence (7 lines below equation (19.2)) should be: "If the sample is 2 red balls and 1 black ball,..."

2. Page 1353, last line in penultimate paragraph should read: Streaks of length $l = 1, 2, \ldots, 6+$ are considered ($6+$ implies $l \geq 6$). Similarly, in the first sentence of the last paragraph replace "lengths 1–6" by lengths "1–6+".

3. Page 1354, second line: replace 6 by 6+. In the same line replace $l = 6$ by $l \geq 6$.

4. Page 1354, sentence starting on line 8 should be: Odean (1998) found that people are 50% more likely to sell winning stock as compared to losing stock.

5. Page 1358, 5 lines up from the equation at the bottom of the page: Replace $\theta \in [0, 1]$ by $\theta \in (0, 1)$.

6. Page 1352 first line of the penultimate paragraph should read: "If subjects produce negative autocorrelation when asked...."

7. Page 1356, 4 lines from the bottom: either delete "(gambler's fallacy)" or replace it by "(opposite of the gambler's fallacy)".

8. Table 19.3 on p. 1367, second column: Replace Mdti by *Mdn*.

9. Page 1373, Section 19.6.3, line 6 in this section: "explain a range of other phenomena" in place of "explain a range of other judgement heuristics."

10. Page 1381, equation (19.17) should be:

$$P(h_n \mid H_b) = \binom{n}{h_n} (0.6)^{h_n} (0.4)^{n-h_n} ; P(h_n \mid T_b) = \binom{n}{h_n} (0.4)^{h_n} (0.6)^{n-h_n} .$$

11. Page 1388, second sentence after equation (19.31) should be: From (19.31), decision makers who are subject to hindsight bias overestimate, ex-post, the probability that the true model is $X \sim N(\mu, \sigma_L^2)$.

12. Page 1393, two lines above (19.36): replace "a confirmation biased individual"by "an individual". Do the same for 1/2 lines above equation (19.37). Delete the word "confirmation biased" one line below equation (19.37). In equation (19.37) and the paragraph following it, replace 4 instances of L^C with L.

13. Page 1394, one paragraph above Definition 19.3, replace the first two sentences starting with "Relative..." by these two sentences: "Now consider a hypothetical unbiased Bayesian statistician who knows that (1) the individual suffers from confirmation bias, (2) has perceived n_α of the signals to be α and n_β to be β, and (3) misperceives signals in the manner outlined above."

14. Page 1402, first line: Shleifer et al. (2008) should be Mullainathan et al. (2008).

15. Page 1404, 3 lines below equation (19.57): Replace $m = \{g, b\}$ by m.

16. Page 1404, end of A5: Replace "signal, s" by "message, m".

17. Page 1421. In Step II, lines 2/3: the expression in the brackets should be: (i.e., $C_i(x) = +, C_i(y) = -$ or $C_i(x) = -, C_i(y) = +$)

18. Page 1433. Second Paragraph is more clearly written as follows: "The hotel sector is assumed to be perfectly competitive. Suppose that a fraction $\alpha \in [0, 1]$ of the customers is *myopic* (myopes) and the remaining fraction $1 - \alpha$ is *sophisticated*. Sophisticates always take account of add-ons (by forming Bayesian posteriors when add-ons are shrouded). Myopic consumers cannot observe shrouded information and do not take account of it.[1] However, when information is unshrouded, a fraction $\lambda \in (0, 1]$ of the myopes takes account of add-ons and behaves like the sophisticates (informed myopes) and the remaining fraction $1 - \lambda$ (uninformed myopes) pays no attention to add-ons whether shrouded or not."

[1] One possibility is that myopic consumers simply do not pay enough attention. Empirical evidence is suggestive of the importance of consumers who exhibit limited attention; see, for instance, DellaVigna and Pollet (2009), Cohen and Frazzini (2008), Hirshleifer et al. (2009), Gilbert et al. (2012).

19. Page 1438, Section 19.7.2, second para last sentence is more clearly written as follows: "Thus consumers show good awareness of the sales tax (and, indeed, could inquire about it from the shop attendant, if required) yet their purchase decisions suggest that taxes that are not displayed on price stickers reduce tax salience."

20. Page 1343, 3rd paragraph from the bottom, last sentence: Switch the words "gambler's" and "hot hands".

10 Corrections to Chapter 20

Page 1465-68. Replace all occurrences of $\sum_{t>k}$ by $\sum_{t\geq k}$.

Page 1470, 4 lines below equation (20.22) replace "...broadly; narrow..." by "...broadly. Narrow..."

Page 1472, 5th paragraph, first line (around the middle of the page): replace "needed" by "required"

11 Corrections to Chapter 21

Page 1496, first line after equation (21.1): Insert the word "instantly" before the word "incorporated"

Page 1499, point (b) line 2 should be "...performs well relative...

Page 1505, 7 lines of text up from the bottom of the page: Replace "...is normally distributed" by "...is additive and normally distributed"

Page 1506, equation (21.19) should end with "$\forall t$ and $j = 2, 3, \ldots$"

Page 1508, 11 lines up from the bottom: Replace "risk asset" by "risky asset".

Page 1512, Second para, fourth line: Delete "$r_g =$".

Page 1513, last para and Page 1514, equations (21.44), (21.45) have a few typos. Here is the correct version:

The RHS of (21.43) depends on D_1^a through p_1, and it is straightforward to check that R is strictly concave in D_1^a. For a corner solution, $D_1^a = F_1$, we require that $\frac{\partial R}{\partial D_1^a} \mid_{D_1^a = F_1} \geq 0$, thus,

$$(1-q)\left(\frac{V}{V-S_1+F_1}-1\right)+q\left(\frac{p_2}{V-S_1+F_1}-1\right)\frac{V}{p_2} \geq 0 \Leftrightarrow D_1^a = F_1. \tag{21.44}$$

For the case $0 < D_1^a < F_1$, we need $\frac{\partial R}{\partial D_1^a} = 0$, thus,

$$(1-q)\left(\frac{V}{p_1}-1\right)+q\left(\frac{p_2}{p_1}-1\right)\frac{V}{p_2} = 0 \Leftrightarrow 0 < D_1^a < F_1. \tag{21.45}$$

Page 1514, last paragraph, the 3rd and 4th sentences should read: "We illustrate the situation in Figure 21.5, for two cases: $f' < 1$ and $f' > 1$. There are two fixed points, p_2^* and p_2^{**}; p_2^* is stable while p_2^{**} is unstable."

Page 1519, Equation (21.57): missing 2 in front of the expression. (21.57) should be $V = 2\lambda(1-\lambda)\left|s_1 - s_2\right|$

Page 1543, equation (21.21): Missing "=" sign just to the left of the curly bracket.

12 Corrections to Part 8

12.1 Corrections to Chapter 22

Page 1584, second para, lines 2/3: Delete "up to order 2"

Page 1586, last para of point 3 starting with "In the context..." replace the two instances of $\overline{\theta}$ with θ.

Page 1587, line 4/5: Delete "at least up to order two"

Pages 1602/3: There is notational confusion with respect to the expected payment to the firm, which has resulted in errors in two equations. Rather than make several corrections which might themselves created further confusion, the correct text, in full, immediately following equation (22.27) on page 1602 to the end of the first equation on page 1603 (just efore the sentence "The expected expenditure...") should be:

The utility function of each consumer, on receiving the signal, θ, is given by

$$U(\theta) = 1 - E\left[x \mid \theta\right] - E\left[M(\theta)\right], \tag{1}$$

where $E\left[M(\theta)\right]$ is the expected monetary payment from the consumer to the firm based on the signal received. In this reduced-form model, utility is decreasing in expected usage to reflect the fact that often when consumers are informed about their usage, they are likely to be surprised by the level of usage, and often switch providers of the service in the hope of getting a better deal.

Suppose that there are two providers of the service, A and B. Firm A charges a fixed monthly price of $P_A = 2$, irrespective of usage, thus, $E[M(\theta)] = 2$. Firm B charges a per unit price equal to $P_B = 1$, so if the usage is $x = 1$ the consumer pays 1 and if the usage is $x = 3$, the consumer pays 3. [2] Thus, if consumers knew their own usage with certainty (and had no need to rely on the signal θ), then those with $x = 3$ would prefer to buy from firm A and those with $x = 1$ from firm B.

Now suppose that consumers did not know their usage with certainty and need to rely on the signal to infer their usage. Consider consumers who receive a high usage signal, $\theta = 3$. For such consumers, we can calculate their utility from buying from firm A, $U(\theta = 3, A)$ and buying from firm B, $U(\theta = 3, B)$ as follows.

$$U(\theta = 3, A) = 1 - E[x \mid 3] - 2.$$

$$\begin{aligned} U(\theta = 3, B) &= 1 - E[x \mid 3] - [3E[3 \mid 3] + E[1 \mid 3]] \\ &= 1 - E[x \mid 3] - (1 + 2\lambda). \end{aligned}$$

Since $\lambda \in \left[\frac{1}{2}, 1\right]$, it follows that $1 + 2\lambda \geq 2$ so $U(\theta = 3, A) \geq U(\theta = 3, B)$. Thus, consumers who receive a high signal will buy from firm A. A simple calculation shows that those who receive a low usage signal will prefer to purchase from firm B because $U(\theta = 1, B) \geq U(\theta = 1, A)$.

Page 1603: To be consistent with the previous correction replace $U(\theta, P)$ by $U(\theta)$ in the last line of Proposition 22.2.

Page 1612, Example 22.6, line 6: Replace g_1 by g_2.

Page 1625-1632: In Section 22.9.1 there is a most unfortunate mistake in that two different kinds of taxes have been mixed up, the ad-valorem tax and the specific tax. This has been caused by two different sets of my notes on this topic being mixed up and this was unfortunately not picked up during the short proofreading process for the book. Rather than sort the confusion out by repeated corrections, I propose to provide you below with the full and correct text for Sections 22.9.1 and 22.9.2.

[2] It is possible to endogenously derive the optimality of different pricing schemes for firms; see, for instance, Piccione and Spiegler (2012).

12.2 Sections 22.9.1 and 22.9.2 on pages 1626-1632: Full text

In Part 7, we noted the effect of limited attention on the demand for a single good under salient and non-salient taxes (Chetty et al., 2009); we assume some familiarity with this material in the discussion below. When taxes are made more salient, individuals reduce their demand for the good. In this section, we first extend this framework to consider the tax incidence and excess burden under limited attention. Then, we consider some reduced-form frameworks that are suitable to model the welfare implications of alternative policies.

12.3 Limited attention and tax elasticities

Suppose that a consumer consumes two goods, x and y, that are in perfectly elastic supply and has the utility function $U(x, y)$. The consumer has exogenous income $I > 0$. Good y is the numeraire good, whose price is normalized to 1, and it is not taxed. Let p denote the pre-tax unit price of good x that is posted on the price stickers and is directly observable to all buyers. The post-tax price of good x is $q = p(1 + t)$, where $t > 0$ is an ad-valorem, or per-unit, consumption tax. Define

$$\tau = 1 + t.$$

Under full attention, denote the solution to the consumer's optimal demand for x by $x^*(p\tau, I)$ and for y by $y^*(p\tau, I)$. We assume that all demands are continuously differentiable in the parameters p, τ, I. All feasible choices for the levels of demand must satisfy the consumer's budget constraint $p\tau x^*(p\tau, I) + y^*(p\tau, I) = I$.

Under classical public finance theory, the consumer takes account of the full post-tax price, q. However, under limited attention, the consumer may not pay full attention to taxes that are not included on the price ticket but are added at the sales register. In order to allow for this possibility, we write the optimal demands as $x^*(p, \tau, I)$ and $y^*(p, \tau, I)$.

The classical case with full attention requires $x^*(p, \tau, I) = x^*(p\tau, 0, I)$ and $y^*(p, \tau, I) = y^*(p\tau, 0, I)$. In other words one could either add the taxes directly to the ticket price (i.e., $x^*(p\tau, 0, I)$) or not add them to the ticket price and leave them to be added later at the sales register (i.e., $x^*(p, \tau, I)$). In both cases, demand should be identical. It follows that under full attention, an increase in the post-tax price, q, on account of an increase in τ, or an increase in p, has identical effects on the demands. Our main focus will be on the demand for good x, so let us write $x(p,\tau,I) \equiv D(p,\tau,I)$ to make the demand connotation salient. Letting $\epsilon_{D,q}$, $\epsilon_{D,p}$, $\epsilon_{D,\tau}$ be, respectively, the elasticity of demand with respect to q, p, τ we have that under full attention, $\epsilon_{D,q} = \epsilon_{D,p} = \epsilon_{D,\tau}$.

Now introduce the possibility of limited attention towards the sales tax. In this case, whether the sales tax is displayed on the price stickers, or imposed at the sales register, has an important effect on demand. Empirical evidence indicates that $\epsilon_{D,p} \neq \epsilon_{D,\tau}$ (Chetty et al., 2009). Indeed, if taxes added at the sales register are more salient, we expect consumers to respond more to price changes than tax changes, so that $\epsilon_{D,p} > \epsilon_{D,\tau}$ (recall that these elasticities are positive numbers). Suppose that the demand curve is of the form $D(p,\tau,I) = Ap^{\beta}\tau^{\theta\beta}$. This demand curve can be derived in a variety of ways.[3] Let us write $D(p,\tau,I)$ in a log-linear form (keeping I fixed).

$$\log D(p,\tau,I) = \alpha + \beta \log p + \theta\beta \log \tau;\ \theta > 0, \beta < 0. \tag{2}$$

In (2), $-\beta = -\frac{\partial \log D}{\partial \log p} = \epsilon_{D,p}$ and

$$\theta = \left(-\frac{\partial \log D}{\partial \log \tau} \Big/ -\frac{\partial \log D}{\partial \log p} \right) = \frac{\epsilon_{D,\tau}}{\epsilon_{D,p}}. \tag{3}$$

Under classical public finance, $\theta = 1$, which ensures $\epsilon_{D,\tau} = \epsilon_{D,p}$ (unlimited attention). However the empirical evidence suggests that $\theta < 1$ because demand is less responsive to taxes, relative to changes in the price of the good, which is relatively more salient. Thus, the magnitude of θ may be taken to be a measure of inattention. While $\theta < 1$ is in agreement with the empirical evidence on consumption taxes, for other taxes, such as estate taxes, the evidence appears consistent with $\theta > 1$ (tax rates are overestimated). From (3), we get the relation

$$\epsilon_{D,\tau} = \theta \epsilon_{D,p} \tag{4}$$

that neatly summarizes the effect of inattention in terms of creating a wedge between the two elasticites.

[3]For instance by specifying a particular form of the utility function. In a working paper, that preceedes their published paper, Chetty et al. (2009), the authors derive this functional form by modelling endogenously the costs of attention and θ is the proportion of consumers who are just indifferent to paying attention or not paying attention to taxes.

12.4 Tax Incidence under limited attention

The problem of *tax incidence* essentially involves figuring out the relative shares of the tax burden borne by producers and consumers of an increase in the tax rate. In order to ensure the log linearity of demand in p, τ in (2), we needed to use ad-valorem taxes. However, for the purposes of tax incidence, it is more convenient to use specific taxes. Henceforth, define a specific tax $\tau > 0$ such that the after-tax price of good x per unit is given by

$$q = p + \tau.$$

The consumer's budget constraint evaluated at the optimal consumption bundles, $x(p, \tau, I)$ and $y(p, \tau, I)$, is

$$(p + \tau)x(p, \tau, I) + y(p, \tau, I) = I \tag{5}$$

Let us introduce producers in a simple manner. Suppose that identical competitive firms produce good x. The cost of production faced by a representative firm is $c(n)$, where n is the number of units of the good produced by a firm, and $c' > 0$, $c'' > 0$. The profit level of the representative firm is given by $\pi = pn - c(n)$. Profit maximizing firms produce at the point where $p = c'(n)$. This equation can be solved for the optimal supply, $S(p)$, of the representative firm as a function of the price of the good. Denote the elasticity of supply by $\epsilon_{S,p} = \frac{\partial S}{\partial p}\frac{p}{S}$.

In a partial equilibrium analysis, we are interested in market clearing in the market for good x, so

$$D(p, \tau, I) = S(p). \tag{6}$$

Define the following two demand elasiticites.

$$\epsilon_{D,q|p} = -\frac{\partial D}{\partial p}\frac{q}{D}; \epsilon_{D,q|\tau} = -\frac{\partial D}{\partial \tau}\frac{q}{D}. \tag{7}$$

The two elasticities in (7) capture the percentage change in demand divided by the percentage change in the after-tax price arising from, respectively, a change in the (i) price, p, and (ii) specific tax rate, τ.

We assume that the analogue of (4) holds for the elasticties in (7), but τ is now a specific tax. Thus, we assume that

$$\epsilon_{D,q|\tau} = \theta\epsilon_{D,q|p};\ \theta < 1, \tag{8}$$

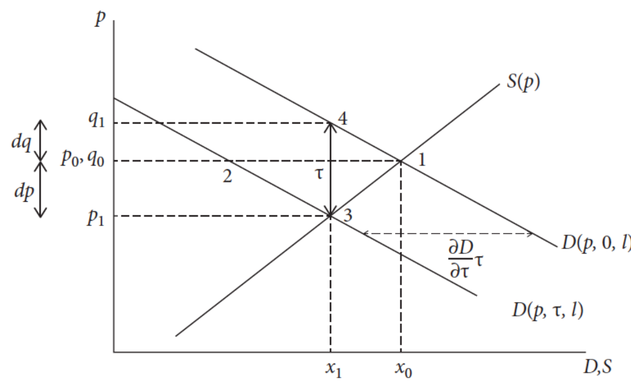

Figure 2: Tax incidence under limited attention.

where $\theta < 1$ captures inattention, or any other factor that drives a wedge between the two elasticities, $\epsilon_{D,q|p}$ and $\epsilon_{D,q|p}$.

Implicit differentiation of (6) gives $\left(\frac{\partial D}{\partial p} - \frac{\partial S}{\partial p}\right) dp + \frac{\partial D}{\partial \tau} d\tau = 0$. Simplifying, using (6), (8), and the definition of supply elasticity $\epsilon_{S,p} = \frac{\partial S}{\partial p}\frac{q}{S}$, we get

$$\frac{dp}{d\tau} = \frac{\frac{\partial D}{\partial \tau}}{\frac{\partial S}{\partial p} - \frac{\partial D}{\partial p}} = -\frac{\epsilon_{D,q|\tau}}{\frac{q}{p}\epsilon_{S,p} + \epsilon_{D,q|p}} = -\frac{\theta \epsilon_{D,q|\tau}}{\frac{q}{p}\epsilon_{S,p} + \epsilon_{D,q|p}}. \tag{9}$$

In (9), the elasticities are evaluated at the optimal solution and the given values of (p, τ, I)The price per unit received by the producers is p, hence the calculation $\frac{dp}{d\tau}$ in (9) gives the incidence of the specific tax on producers. Consumers pay the price q, hence using the relation $q = p + \tau$, we can find the incidence of the specific tax on consumers as $\frac{dq}{d\tau} = 1 + \frac{dp}{d\tau}$. Using (9) and applying (8) to eliminate $\epsilon_{D,q|\tau}$, we can rewrite this as

$$\frac{dq}{d\tau} = \frac{\frac{q}{p}\epsilon_{S,p} + (1-\theta)\,\epsilon_{D,q|p}}{\frac{q}{p}\epsilon_{S,p} + \epsilon_{D,q|p}}. \tag{10}$$

Figure 2 shows the effect of tax incidence under limited attention; the pretax price is measured on the vertical axis and the quantities demanded and supplied of good x are measured on the horizontal axis. The original equilibrium at a zero tax rate is shown at point 1. The corresponding pre-tax equilibrium price is p_0 and the equilibrium quantity is x_0; since the tax rate is zero, so the pre-tax and the post-tax prices coincide, $p_0 = q_0$. Consider now an increase in the tax rate to $\tau > 0$. The increase in the tax rate shifts the demand curve inwards by $\frac{\partial D}{\partial \tau}(\tau - 0)$. At the existing equilibrium price, p_0, there is an excess supply of the good, equal to $\frac{\partial D}{\partial \tau}\tau$, where $\frac{\partial D}{\partial \tau}$ is evaluated at $p = p_0$. In order to clear the market, competition among producers ensures that the equilibrium price falls to $p = p_1$ and the equilibrium quantity falls to x_1; the new equilibrium point is labeled 3. The post-tax price, $q_1 = p_1 + \tau$ is also shown in the figure and τ is shown as the vertical distance between points 3 and 4. The total tax revenue collected by the government is τx_1.

Clearly, the change in the price $dp = p_0 - p_1 < \tau$. Thus, producers bear a part of the burden of an increase in the tax burden, shown by the area $(p_0 - p_1)\, x_1$. The remaining tax burden, shown as the area $dqx_1 = (q_1 - p_0)\, x_1$, is borne by the consumers. Thus, $\tau x_1 = (p_0 - p_1)\, x_1 + (q - p_0)\, x_1 \equiv x_1 dp + x_1 dq$ gives the split of the increased tax revenues between that paid by firms and consumers, although the tax is levied only on the consumers. Under full attention, we have $\theta = 1$, so $\frac{\partial D}{\partial \tau} = \frac{\partial D}{\partial p}$. Thus, in Figure 2, we could have shown the leftward shift in demand as $\frac{\partial D}{\partial p}\tau$, which is not the case under limited attention ($\theta < 1$); this is the only difference in Figure 2 relative to the standard model in public finance.

From (9), $\frac{dp}{d\tau}$ is directly proportional to the size of θ. In the extreme case of no attention, $\theta = 0$, we have $\frac{dp}{d\tau} = 0$, so producers do not bear any burden of the tax increase; consumers bear the entire tax burden. As θ increases, the relative tax burden borne by the producer increases, and correspondingly, the tax burden on the consumer falls. It is tempting to conclude that if consumers pay less than full attention to an increase in the tax rate, it is as if their demand is inelastic, hence, producers can pass a greater amount of the tax rate to final consumers. From (8) we know that $\epsilon_{D,q|\tau} = \theta \epsilon_{D,q|p}$, so a change in θ or a change in $\epsilon_{D,q|p}$ have similar effects on $\epsilon_{D,q|\tau}$, yet their effect on tax incidence is different.

To see this, suppose we have two economies, A and B, with identical supply elasticities $\epsilon^A_{S,p} = \epsilon^B_{S,p} = 0.1$. In economy A, all consumers are neoclassical and display perfect attention ($\theta^A = 1$), but in economy B they display limited attention ($\theta^B = 0.3 < 1$). Demand in economy A is inelastic ($\epsilon^A_{D,q|p} = 0.3$) while in economy B it is more elastic ($\epsilon^B_{D,q|p} = 1$). Thus, in each case we have $\epsilon^A_{D,q|\tau} = \epsilon^B_{D,q|\tau} = 0.3$. However, using (9), we have $\left(\frac{dp}{d\tau}\right)_A = -0.75$ and $\left(\frac{dp}{d\tau}\right)_B = -0.27$. Producers in economy A bear a larger share of the tax despite full attention. However, the limited attention in economy B allows its producers to shift a greater share of the tax to its consumers. Following an increase in the tax rate, inattention only shifts down the demand curve (as in Figure 2). In contrast, a lower elasticity of demand reduces the inward shift in demand and also requires a larger price cut (size of $p_0 - p_1$ in Figure 2) to establish the new equilibrium where demand equals supply.

From (9), if we hold fixed the tax elasticity of demand, $\epsilon_{D,q|\tau}$, a larger value of the price elasticity $\epsilon_{D,q|p}$ reduces the absolute value of the change $\left|\frac{dp}{d\tau}\right|$ needed to equilibrate markets. However, it is possible that the degree of attention given may also depend on the price elasticity, in which case one would need to model the covariance between θ and $\epsilon_{D,q|p}$.

12.5 Excess burden under limited attention

Let us now use the setup in Section 12.4 to calculate the excess burden of taxation. It is more convenient to revert back to using $x(p,\tau,I)$ instead of $D(p,\tau,I)$. We also specialize the utility function $U(x,y)$ to an additively separable function, $U(x,y) = u(x) + v(y)$. Assume that initially, the commodity tax rate is zero ($\tau = 0$). Suppose that there are constant returns to scale in production and firms are perfectly competitive, so each firm makes zero profits. Thus, welfare measurements can be equated purely with consumer welfare.

Substituting the optimal solutions $x(p,\tau,I)$ and $y(p,\tau,I)$ into the utility function, we get the indirect utility function

$$V(p,\tau,I) = u(x(p,\tau,I)) + v(y(p,\tau,I)). \tag{11}$$

Let $V(p,\tau_1,I)$ be the indirect utility at a price p and specific tax rate, τ_1. Let the expenditure function be denoted by $e(p,\tau_2,V(p,\tau_1,I))$; it is the minimum expenditure required to achieve the level of utility $V(p,\tau_1,I)$ when the price is p and the specific tax rate is τ_2. We denote government revenue under the specific tax by $R = \tau x(p,\tau,I)$. From (5), we have that the consumer budget constraint can be written as:

$$px(p,\tau,I) + y(p,\tau,I) = I - \tau x(p,\tau,I) \equiv I - R(p,\tau,I). \tag{12}$$

The LHS of (12) is the total expenditure on consumption goods, and the RHS is the total disposable income.

We now use these concepts to define the excess burden, or deadweight loss, of a consumption tax by

$$EB(\tau) = I - R(p,\tau,I) - e(p,0,V(p,\tau,I)). \tag{13}$$

$I - R(p, \tau, I)$ is the disposable income when the distortionary consumption tax rate is τ, and the corresponding indirect utility is $V(p, \tau, I)$. Suppose that we ask what expenditure is needed to achieve a utility of $V(p, \tau, I)$ when we remove the distortionary tax and replace it by a lump-sum tax, L? The budget constraint with a lump-sum tax is $px(p, 0, I) + y(p, 0, I) = I - L$. Since there are no distortions associated with a lump-sum tax, hence, the same level of utility can be achieved with a lower expenditure, $e(p, 0, V(p, \tau, I))$. Thus, the RHS of (13) measures the extra expenditure required under a distortionary tax to achieve the same level of utility as a lump-sum tax; in other words, it is the deadweight loss associated with the tax.

An issue in most behavioral welfare analyses where people do not strictly optimize is to compute the indirect utility $V(p, \tau, I)$. The indirect utility function is obtained by substituting the optimal choices into the utility function. Suppose, as an extreme example, that an individual pays no attention to tax rates ($\theta = 0$). Then, as the tax rate changes, the individual does not choose the optimizing bundles of x, y, thus making it difficult to define an indirect utility function. In order to deal with this problem, consider two assumptions.

A1: Taxes do not directly affect the utility function. Rather, taxes only affect the utility function indirectly through changes in the demands $x(p, \tau, I)$ and $y(p, \tau, I)$. In other words, the indirect utility function is as given in (11).

A2: When tax-inclusive prices are fully salient, the agent chooses the same allocation as a fully-optimizing agent. Recall from Section 12.3 that, given our notation above, $x(p, \tau, I)$ is the consumption bundle under limited attention, and $x(p + \tau, I)$ is the consumption bundle under of a fully optimizing consumer who gives full attention to the tax rate.We require that these two consumption bundles are identical when $\tau = 0$, i.e.,

$$x(p, 0, I) = x(p + 0, I). \tag{14}$$

The implication of (14) is that under limited attention, we can discover the underlying preferences of a decision maker who exhibits limited attention, if $\blacksquare = 0$; when $\blacksquare = 0$, there are no issues of inattention.

It is best to examine conditions under which these assumptions are violated in order to understand them better.

Assumption A1 is not likely to hold if taxes directly influence individual utility. This may happen, for instance, (1) if individuals are troubled by the fairness of the fiscal system (e.g., those individuals who feel that the tax system is unfair may evade more taxes), or (2) if individuals must expend costly cognitive effort to give more attention to taxes. In these cases, instead of (11), the indirect utility function may have to be written as $\tilde{V}(p, \tau, I) = u(x(p, \tau, I), \tau) + v(y(p, \tau, I), \tau)$. Assumption A2 can be violated even when in the absence of taxes, individuals do not choose the optimal consumption bundles; for instance, under *shrouded attributes* (see Volume 5).

Thus, our strategy is to first use (14) to compute the individual's underlying preferences, and then use the Marshallian demand functions under limited attention, $x(p, \tau, I)$ and $y(p, \tau, I)$, to compute the indirect utility function in (11).

Denote by $h = h(p, \tau, V)$ the Hicksian or compensated demand for good x, under limited attention. Then assumption A2, and the Slutsky equation implies

$$\frac{\partial h}{\partial p} = \frac{\partial x}{\partial p} + x\frac{\partial x}{\partial I}. \tag{15}$$

Demands, Hicksian or Marshallian, optimally respond to prices, so we have the usual condition $\frac{\partial h}{\partial p} < 0$. However, due to limited attention, there is no presumption that demands respond optimally to changes in the tax rate, τ. So if we define

$$\frac{\partial h}{\partial \tau} = \frac{\partial x}{\partial \tau} + x\frac{\partial x}{\partial I}, \tag{16}$$

then there is no presumption that $\frac{\partial h}{\partial \tau} < 0$. Using notation used above in (7), define the compensated elasticities of demand with respect to p and τ by $\epsilon_{h,q|p} = -\frac{\partial h}{\partial p}\frac{q}{h}$ and $\epsilon_{h,q|\tau} = -\frac{\partial h}{\partial \tau}\frac{q}{h}$.

Proposition 1 *(Chetty et al., 2009): Suppose that the supply curve is infinitely elastic ($\epsilon_{S,p} = \infty$), initial commodity tax rate is zero ($\tau = 0$), assumptions A1 and A2 hold, producer prices are fixed, and our measure of excess burden is given (13).*

(a) Evaluating all derivatives at $(p, 0, I)$, and defining the compensating attentional parameter $\theta^c = \left(\frac{\partial h}{\partial \tau}/\frac{\partial h}{\partial p}\right) = \frac{\epsilon_{h,q|\tau}}{\epsilon_{h,q|p}}$, the excess burden of in-

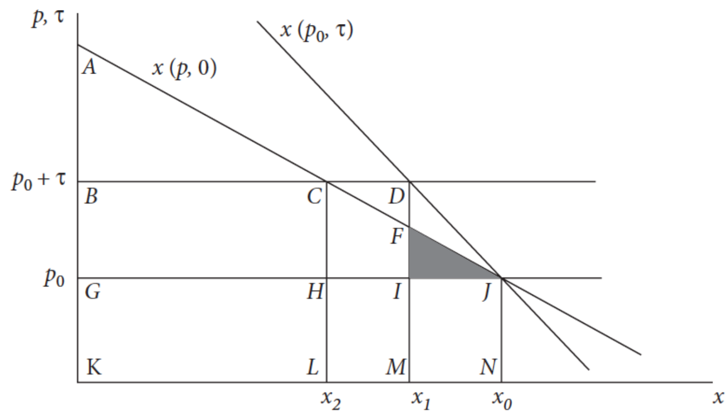

Figure 3: The excess burden of taxation under limited attention.

troducing a small positive tax ($\tau > 0$), $EB(\tau)$, is

$$EB(\tau) \simeq \frac{-1}{2}\tau^2\theta^c\frac{\partial h}{\partial \tau} = \frac{1}{2}(\tau\theta^c)^2 x(p,\tau,I)\frac{\epsilon_{h,q|p}}{p+\tau}. \quad (17)$$

(b) *In the special case of full attention, excess burden is a special case of the formula in (17), with $\theta^c = 1$.*

(c) *Suppose that the initial tax is non-zero, $\tau_0 > 0$, and the tax is now increased to $\tau_0 + \Delta\tau$. Let the initial demand be x_0 and the initial price be $q_0 = p + \tau_0$. Then, the excess burden is given by the formula*

$$EB(\tau) \simeq \frac{-1}{2}\theta^c\frac{x_0}{q_0}\epsilon_{h,q|\tau}\left(\tau_0\Delta\tau + \frac{1}{2}(\Delta\tau)^2\right).$$

Two things are immediate from Proposition 1. First, the formula for the excess burden is a second order Taylor series approximation that ignores all higher order terms, so the approximation holds best for small tax rates only. Second, the formulae under limited attention and under full attention are identical, except for the presence of the term, θ^c.

In Figure **??**, we show the excess burden of taxation in the special case when there are no income effects, $\frac{\partial x}{\partial I} = 0$ (e.g., underlying utility function is quasilinear). So to save on notation, we replace $x(p,\tau,I)$ by $x(p,\tau)$. The

Slutsky equation in (15) shows that in this case $\frac{\partial h}{\partial p} = \frac{\partial x}{\partial p}$; in the presence of income effects we would have to consider Hicksian demands in Figure **??**. In the absence of income effects, we can also replace θ^c by θ in (17).

Two kinds of demand curves are shown in Figure **??**. $x(p, 0)$ is the demand curve when $\tau = 0$, and it shows how optimal demand varies under limited attention when the price alone varies. Under assumption A2 it is equivalent to the marginal utility curve $u'(x)$ so it captures the marginal willingness to pay for x in the absence of taxation. The initial commodity price of good x is p_0, and $\epsilon_{S,p} = \infty$, so the supply curve is horizontal at p_0. The demand curve $x(p_0, \tau)$ shows the variation in optimal demand when price is fixed at p_0, but the tax rate, τ, varies. In the figure, we have shown $x(p_0, \tau)$ to be steeper relative to $x(p, 0)$; this is consistent with the empirical evidence that consumers respond relatively less to taxes as compared to prices that are more salient.

The equilibrium when $\tau = 0$ is shown at point J and the consumer demands x_0 units at a price p_0 per unit. Now suppose that we impose a commodity tax $\tau > 0$ on x so that the post-tax price of x is $p_0 + \tau$. In response to an increase in the tax, a consumer who is attentive to the tax reduces demand from x_0 to x_1. However, at a level of demand x_1, the marginal willingness to pay is lower than $p_0 + \tau$ due to the limited attention given to taxes. Suppose that the marginal willingness is given by the vertical distance FM. Let us use as our measure of welfare, the sum of consumer surplus and government tax revenues (our assumptions ensure profits of firms are zero). Before the imposition of the tax, tax revenues are zero and consumer surplus is AGJ, so initial total welfare is AGJ. After the imposition of the tax, consumer surplus is $AKMF - BKMD = ABC - CDF$. Total government tax revenues equal $BGIFC + CDF$. Thus, total welfare after the imposition of the tax is $ABC + BGIFC$. The difference in the levels of welfare in the two cases is $AGJ - (ABC + BGIFC) = FIJ$; this is the excess burden of the tax and is shown as the shaded area in Figure **??**.

As noted above, in the absence of income effects, $\frac{\partial x}{\partial I} = 0$, so we may write $EB(\tau) \simeq \frac{1}{2}(\tau\theta)^2 x(p, \tau, I)\frac{\epsilon_{x,q|p}}{p+\tau}$ (Proposition 1(a)). Thus, if $\theta = 0$ (tax changes are ignored, so extreme limited attention), then $EB(\tau) \simeq 0$. The reason is that starting from a zero tax rate, if the imposition of a positive tax rate is ignored by the individual, then there are no substitution effects, hence there is no deadweight loss either. When $\theta = 0$, the budget constraint of the consumer must nevertheless be respected on imposition of the tax. Thus, the distortionary tax under extreme limited attention ($\theta = 0$) becomes just a lump-sum tax, that leads to a choice of the first best consumption bundle. On the other hand, if $0 < \theta < 1$ then the excess burden increases with the square of θ, just as it does for the tax rate, τ. Thus, limited attention reduces the excess burden of taxation, which is welfare improving. In classical public finance theory, it does not matter if taxes are imposed on consumers or producers. However, under limited attention, the two taxes may lead to different effects. The reason is that taxes on producers are often included in the posted price of the good, hence, they are more salient (higher θ); thus the excess burden arising from these taxes is relatively greater.

Going back to Figure **??**, where we assumed $\frac{\partial x}{\partial I} = 0$, suppose that starting from a price of p_0, the curve $x(p, 0)$ becomes steeper (price elasticity reduces), while the curve pivots around the point J. Then the area FIJ expands, so the excess burden increases.

If there are income effects $\frac{\partial x}{\partial I} > 0$, then limited attention may increase the excess burden of taxation; this result arises even if $\theta = 0$, so the consumer pays no attention to tax, $\frac{\partial x}{\partial \tau} = 0$. When $\frac{\partial x}{\partial \tau} = 0$, we get from (16) that $\frac{\partial h}{\partial \tau} = x\frac{\partial x}{\partial I}$. Substitute this, and $\theta^c = \left(\frac{\partial h}{\partial \tau} / \frac{\partial h}{\partial p}\right)$, into the first line of (17), to get

$$EB(\tau) \simeq \frac{-1}{2}(\tau x)^2 \left(\frac{\partial x}{\partial I} \Big/ \frac{\partial h}{\partial p}\right) \frac{\partial x}{\partial I} > 0. \tag{18}$$

The sign in (18) follows because $\frac{\partial h}{\partial p} < 0$. Thus, under complete inattention, we can get a positive excess burden of taxation when there are income effects.

To see this, consider an example in which x is the number of visits to the theater and y is food. Suppose that the government levies tax, $\tau > 0$, on theater visits and the consumer is completely inattentive to these taxes ($\theta = 0$). The budget constraint of the consumer is given by $(p + \tau)\, x(p, \tau, I) + y(p, \tau, I) = I$. Differentiate both sides with respect to τ to get

$$\frac{\partial x}{\partial \tau} + \frac{\partial y}{\partial \tau} = -x.$$

Thus, one method by which the budget may be balanced is that the individual ignores the effect of tax on x, i.e., sets $\frac{\partial x}{\partial \tau} = 0$. In this case, as the consumer's income goes down after paying the tax, the full effect is felt as a decrease in the consumption of food, y. Thus, the new income level, net of taxes, is not allocated efficiently between theater visits and food, which creates a deadweight loss from taxation, hence, the excess burden is positive.

Finally, note from Proposition 1, when tax increases are imposed on pre existing positive tax rates, then the tax increases can have first order effects (as in the term $\tau_0 \Delta\tau$), although these effects are weakened by inattention (low values of θ^c).

End of Sections 22.9.1 and 22.9.2

Page 1633, Example 22.21 is too cryptic. Replace it by the following text: Let b denote benefits and $q(t)$ the costs from an action. Then, the decision rule in the absence of nudges is $b > q(t)$. Suppose that there are $j = 1, 2, \ldots, k$ possible nudges that may induce (or deter) the individual to take the relevant action. Denote the j^{th} nudge by $d_j(b,t)$. Then, using (22.59), the decision rule in the presence of the j^{th} nudge is $b + d_j(b,t) > q(t)$.

13 Part 9 Neuroeconomics

13.1 Corrections to Chapter 23

Page 1662: Penultimate sentence shoud read: Single neuron studies in monkeys show that decision value signals exhibit *range adaptation*, i.e., the neuronal firing rate is a linear function of the range of values given (Padoa-Schioppa, 2009; Padoa-Schioppa and Assad, 2006).

Page 1668: Replace the second paragraph by the following text:

A non-parametric method was also employed to correlate brain activity with the behavioral shape of the Prelec function.[4] Each of the probabilities is assigned a dummy variable, $d(p_i)$ (e.g., $d(p_i) = 1$, $d(p') = 0$ for $p_i \neq p'$). Letting z be the BOLD response in the brain, captured by the fMRI evidence, the relation

$$z = a + \beta_i d(p_i) v(x) + \varepsilon \tag{19}$$

was estimated; ε is a noise term and a, β_i are the parameters to be estimated. Each β_i (for each of the 6 probabilities) is then rescaled by dividing with the slope of the regression coefficient of the linear term in a regression of z on the linear and the deviation $(\pi(p,\alpha) - p)$ terms.

Page 1668: In light of the previous correction, replace the wording of the caption with: The rescaled coefficient β_i (shown as the dots)...

[4] Note that the inverse S-shape of the Prelec function arises for $\alpha < 1$ but not for $\alpha > 1$, which is also admissible under the axioms that lead to the Prelec function; see al-Nowaihi and Dhami (2006).

Page 1674, Figure 23.17: Missing text in caption: Panel A is the leftmost panel; panel B is the middle panel; panel C is the rightmost panel.

Page 1676, last paragraph, first line: Replace "proposers" with "responders".

Page 1690, third para first line: Replace "probability p" by "number p"

Page 1692, line 5 and footnote 24: Replace "conservationists" by "conservatives".

End of Corrections

14 Corrections to Appendix on game theory

Page 1703, third para, first line, replace "utility function" by "payoff"

Page 1703, Section A2, third para, line 1, replace "strategy" by "strategies"

Page 1707, line 3, replace N by n.

Page 1714: 4th para, 5th line, term in brackets should be: ($d_1 \notin P(d_2)$ and $d_2 \notin P(d_1)$).

Definition A.10: The following is a slightly more pedantic way of writing parts (a) and (b) but ensures that there is no confusion, which could have arisen from the earlier shorthand notation:

Definition 2 *1.*

(a) *If any signal is played by a sender of type t with strictly positive probability, then it must be a maximizing choice for the sender. Thus, if $\sigma_1(s^*, t) > 0$ then*

$$s^* \in \arg\max \sum_{s \in S_1} \sum_{a \in S_2} \sigma_1(s,t)\, \sigma_2(a,s)\, u_1(t,s,a), \ \forall t. \tag{A.15}$$

(b) *On receiving a signal s, if any action a is played with strictly positive probability by the receiver, then it must maximize the receiver's expected utility. Thus, if $\sigma_2(a^*, s) > 0$ when signal s is observed, then*

$$a^* \in \arg\max \sum_{t \in T} \mu(t \mid s) \left[\sum_{s \in S_1} \sum_{a \in S_2} \sigma_1(s,t)\, \sigma_2(a,s)\, u_2(t,s,a) \right], \ \forall s. \tag{A.16}$$