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From Continuous to Discrete: An Alternative Approach to Teaching Consumer Choice

In many principles of microeconomics courses, the concept of consumer choice is not covered due to its complexity. However, this severely limits students who plan to enroll in an intermediate microeconomics course in the future. This paper offers a strategy for teaching consumer choice through indifference curves to these introductory students. Introducing this material in a principles course will aid the students' comprehension when they are later enrolled in an intermediate microeconomics course. Converting a continuous indifference curve map into a discrete form allows students to see consumer choice from a different angle. After students understand this discrete form, the instructor may demonstrate the relationship to income and substitution effects.

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1. Introduction

Anyone who teaches an introductory or principles of microeconomics course knows that one major challenge is that there are many topics that may be covered. After talking with many different instructors across the country, the general consensus is that there is not enough time in a term to cover all of the material. There is a tradeoff for many instructors as to which material should be covered and what needs to be excluded. One such topic an instructor may choose to omit is the topic of indifference curves, because the material appears only in an appendix in many principles of microeconomics textbooks. However, the indifference curve model helps students understand the reasons why consumption decreases when the price increases (namely, income and substitution effects), the effects of policies on consumers, and how individuals respond to changes in incentives. In addition, the understanding of indifference curves at a beginning economics level will help bridge understanding and insight into more advanced economics courses in the future.

One reason many authors do not put much emphasis on indifference curves or income and substitution effects in their principles of microeconomics textbooks is that the material may be too difficult for many students. For example, in their appendix titled, "Indifference Curve Analysis," Mateer and Coppock (2018) state "The purpose of this appendix is to get you thinking at a deeper level about the connections between price changes and consumption decisions." Additionally, Sexton (2016) titles his appendix to consumer choice, "A More Advanced Theory of Consumer Choice." This approach could be useful for colleges where most students use the microeconomics principles course to fulfill a general education requirement or because it is necessary before taking business courses; in these instances, covering indifference curves may not be that important. However, colleges that turn out many economics majors or require intermediate microeconomics for business programs should consider incorporating the concept of indifference curves in the principles course, because this will help students prepare for the intermediate economics course.

In most principles of microeconomics textbooks, indifference curves are introduced right after utility. Instructors generally cover the principle of diminishing marginal utility and the utility-maximization rule, given that these topics are covered in every principles of microeconomics textbook. One way to reinforce the utility-maximization rule is to look at a discrete example as demonstrated by Chiang (2017), Colander (2017), Hubbard and O'Brien (2015), Krugman and Wells (2015), Mateer and Coppock (2018), O'Sullivan et al. (2014), Parkin (2016), and Sexton (2016). The example has an individual consuming two goods; a table is presented that provides the total utility, marginal utility, and the marginal utility per dollar for varying discrete amounts of each good. The consumer determines the optimal amount of each good that should be purchased given a particular budget. The purpose for giving the example on a discrete level is not only to demonstrate the importance of marginal utility but also the influence of price in a consumption set; thus, this reinforces the utility-maximization rule. Using a bit of algebra, the utility-maximization rule demonstrates that the slope of the indifference curve equals the slope of the budget constraint.

One approach to teaching consumer choice can be found in Taylor and Weerapana's (2013) principles textbook. This introduces indifference curves for a discrete case in a two-good scenario. This approach is also addressed in Bernheim and Whinston's (2014) intermediate microeconomics textbook as well as Goolsbee et al. (2016) when discussing the long-run production function. However, Taylor and Weerapana (2013) take it to the next step by applying the budget constraint. The cells the consumer can afford are highlighted, and the consumer will purchase the consumption set that provides the highest level of utility given those available.

Some principles of microeconomics textbooks cover consumer choice, but do not introduce indifference curves (Frank and Bernanke 2013, Gwartney et al. 2015, O'Sullivan et al. 2014). One author said that he puts more established economic theory at the beginning of his textbook and concepts that are more abstract at the end; therefore, he included indifference curves in the consumer choice chapter that appears near the end of his textbook (Mankiw 2011). The principles text by Cowen and Tabarrok (2015) also introduces indifference curves in the consumer choice chapter near the end of the textbook.

Table 1 – List of Chapters in Intermediate Microeconomics Texts & Where Topics Are Covered

Author(s)	Publisher	Topic: Indifference Map	Topic: Edgeworth Box	Topic: Producer Theory
Banerjee (2015)	Routledge	3, 4, 5*	6	7, 8
Bernheim & Whinston (2014)	McGraw-Hill	4, 5*, 6	16	7, 8
Frank (2015)	McGraw-Hill	3, 4*, 5		9
Goolsbee, Levitt, & Syverson (2016)	Worth	4, 5*	14	6
Landsburg (2014)	Cengage	3, 4*	8	6
Mansfield & Yohe (2003)	Norton	2, 3*	16	6, 7
Mochrie (2015)	Worth	4, 5, 6, 7, 8*	21	10, 11, 12
Nicholson & Snyder (2010)	Cengage	2, 3*		6
Nechyba (2017)	Cengage	4, 5, 6, 7*, 8, 9	16	12
Perloff (2015)	Pearson	4, 5*	10	6, 7
Pindyck & Rubinfield (2013)	Pearson	3, 4*	16	6, 7
Schotter (2009)	Cengage	3*, 4, 5, 6	20, 21	8
Varian (2014)	Norton	2, 3, 4, 5, 6, 7, 8*, 9, 10	32, 35	19, 21
Wetzstein (2013)	Routledge	2, 3, 4*, 5	6	7, 8

* denotes the chapter that introduces income and substitution effects.

Given that most mainstream textbooks only introduce indifference curves in the appendix of the consumer choice chapter (or introduce it at the end of the textbook) suggests that the topic may not be of high importance. However, indifference curves are utilized in multiple chapters for a handful of intermediate microeconomics textbooks (see Table 1).

The students enrolled in intermediate microeconomics will also need to know about income and substitution effects (all the textbooks listed in Table 1 cover this particular topic). In addition to indifference curves, students will need to be familiar with that type of model when discussing the Edgeworth Box and producer theory. For some students this could be

overwhelming, since a topic that was only covered in an appendix in their principles course is now a major focus for the subsequent course in microeconomics.

An extension to indifference curves in an intermediate microeconomics course is the concepts of income and substitution effects. Most principles of microeconomics textbooks published by Cengage Learning, Macmillan Learning, McGraw-Hill Education, and Pearson Education introduce income and substitution effects, but only by definition, and they relate the terms only to demand. Some textbooks only introduce income and substitution effects in terms of the labor-leisure model when discussing the labor market (for example Arnold 2016;, Baumol and Blinder 2016;, and Feigenbaum and Hafer 2013). The three textbooks that cover indifference curves in a specific chapter (rather than in an appendix), Cowen and Tabarrok (2015), Mankiw (2015), and Parkin (2016), all explain the relationship of the income and substitution effects to indifference curves. Although most textbooks introduce indifference curves in an appendix, few of them address the relationship to the income and substitution effects. Some examples are Hubbard and O'Brien (2015), Karlan and Morduch (2014), Krugman and Wells (2015), Sexton (2016), and Taylor and Weerapana (2013). In summary, of the 16 textbooks discussed, nine cover indifference curves in an appendix (three of these nine cover income and substitution effects), while four cover indifference curves in a chapter (with two of the four covering income and substitution effects).

This paper will demonstrate an alternative way in which instructors can teach the concept of indifference curves and relate them to income and substitution effects, allowing students to be familiar with the subject matter when they enroll in intermediate microeconomics and other advanced economics courses. This alternative approach is to use a detailed discrete indifference map rather than continuous indifference curves. Using the discrete approach should complement the continuous model so that students can see the indifference-curves model from a different angle; ideally students should see many different examples of any model. Seeing the model from a different perspective may help the student understand the concepts taught in the model.

2. The Approach

Before discussing indifference curves and income and substitution effects, the students should be familiar with incentives, scarcity, trade-offs, demand, normal and inferior goods, and utility. The instructor may want to review these topics before introducing indifference curves. Then, a discrete consumption choice set as shown in Table 2 should be displayed to students.[1] The number in the each cell represents the level of utility the consumer receives from consuming the respective amount of good x and good y. The utility table is expressed by the utility function, $U = xy$, except for the case when 7 units of good x and 14 units of good y are consumed.[2] The instructor may want to discuss the axiom of non-satiation because this table does not exhibit the principle of diminishing marginal utility.

After the students are familiar with Table 2, the concept of indifference curves can be introduced to students. Each cell will have the same value as at least one other cell except for when there are 14 units of good x and 7 units of good y, when there is 1 unit of each, and when there are 20 units of each. There are some values of utility that appear in several cells. For example, the utility of 60 is attained with eight different combinations: 3 units of x and 20 units of y, 4 units of x and 15 units of y, 5 units of x and 12 units of y, 6 units of x and 10 units of y, 10 units

1 This is similar but larger to the one presented in Taylor and Weerapana (2013).

2 This change has been made to help explain the substitution and income effects.

of x and 6 units of y, 12 units of x and 5 units of y, 15 units of x and 4 units of y, and 20 units of x and 3 units of y. For each of these different combinations of good x and y, the consumer is indifferent; therefore, all of these combinations lie on the same indifference curve. The students should understand that, for the continuous case, the indifference curves are lines, convex to the origin. The instructor may want to explain that one of the assumptions in the model is that the indifference curves do not cross.

Table 2 – Indifference Map 1: Total Utility Derived from Consuming Goods x and y

Consumption of Good y																				
20	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400
19	19	38	57	76	95	114	133	152	171	190	209	228	247	266	285	304	323	342	361	380
18	18	36	54	72	90	108	126	144	162	180	198	216	234	252	270	288	306	324	342	360
17	17	34	51	68	85	102	119	136	153	170	187	204	221	238	255	272	289	306	323	340
16	16	32	48	64	80	96	112	128	144	160	176	192	208	224	240	256	272	288	304	320
15	15	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	285	300
14	14	28	42	56	70	84	100	114	126	140	154	168	182	196	210	224	238	252	266	280
13	13	26	39	52	65	78	91	104	117	130	143	156	169	182	195	208	221	234	247	260
12	12	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192	204	216	228	240
11	11	22	33	44	55	66	77	88	99	110	121	132	143	154	165	176	187	198	209	220
10	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
9	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135	144	153	162	171	180
8	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160
7	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
6	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
5	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
4	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
3	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
2	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Consumption of Good x

Once the students are comfortable with indifference curves, the budget constraint may now be introduced into the model.[3] As demonstrated in Taylor and Weerapana (2013) the cells that the consumer can afford should be highlighted. For example, given the situation presented in Table 2, the price of both goods x and y could be $1 with an income of $20. The students would highlight the cells that the consumer could afford. The instructor may want to go over what cells to highlight as a class.

3 Alternatively the budget constraint could be introduced before indifference curves.

Table 3 – Indifference Map 1: Budget Constraint when $P_x = P_y = \$1$ and Income = \$20

Consumption of Good y																					
20	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400
19	19	38	57	76	95	114	133	152	171	190	209	228	247	266	285	304	323	342	361	380
18	18	36	54	72	90	108	126	144	162	180	198	216	234	252	270	288	306	324	342	360
17	17	34	51	68	85	102	119	136	153	170	187	204	221	238	255	272	289	306	323	340
16	16	32	48	64	80	96	112	128	144	160	176	192	208	224	240	256	272	288	304	320
15	15	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	285	300
14	14	28	42	56	70	84	100	114	126	140	154	168	182	196	210	224	238	252	266	280
13	13	26	39	52	65	78	91	104	117	130	143	156	169	182	195	208	221	234	247	260
12	12	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192	204	216	228	240
11	11	22	33	44	55	66	77	88	99	110	121	132	143	154	165	176	187	198	209	220
10	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
9	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135	144	153	162	171	180
8	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160
7	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
6	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
5	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
4	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
3	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
2	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Consumption of Good x

After the cells have been highlighted correctly (see Table 3) the student will be able to tell what combination of good x and good y will give the consumer the highest level of utility. In the case when the price of both goods is \$1 and income is \$20, the consumer would choose to consume 10 units of each good resulting in 100 utils of utility (see Table 3). Then using a different highlighter or another copy of Table 2, the student should highlight the cells the consumer can afford when the price of good x increases to \$2, given that the price of good y and incomestay the same. For this situation the consumer will now consume 5 units of good x and 10 units of good y and receive 50 utils of utility as shown in Table 4.

Table 4 – Indifference Map 1: Budget Constraint when P_x = \$2, P_y = \$1, and Income = \$20

Consumption of Good y																					
20	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400
19	19	38	57	76	95	114	133	152	171	190	209	228	247	266	285	304	323	342	361	380
18	18	36	54	72	90	108	126	144	162	180	198	216	234	252	270	288	306	324	342	360
17	17	34	51	68	85	102	119	136	153	170	187	204	221	238	255	272	289	306	323	340
16	16	32	48	64	80	96	112	128	144	160	176	192	208	224	240	256	272	288	304	320
15	15	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	285	300
14	14	28	42	56	70	84	100	114	126	140	154	168	182	196	210	224	238	252	266	280
13	13	26	39	52	65	78	91	104	117	130	143	156	169	182	195	208	221	234	247	260
12	12	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192	204	216	228	240
11	11	22	33	44	55	66	77	88	99	110	121	132	143	154	165	176	187	198	209	220
10	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
9	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135	144	153	162	171	180
8	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160
7	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
6	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
5	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
4	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
3	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
2	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Consumption of Good x

Now, the instructor can demonstrate that when the consumer receives enough money to afford the original consumption bundle as before (10 units of good x and 10 units of good y), given the price of good x is \$2 and the price of good y is \$1, a different consumption bundle will be consumed. When the price of good x is \$2 the slope of the budget constraint now becomes -2. The instructor or student will highlight the cells until the original consumption bundle is reached using a different highlighter or another copy of Table 2. One way to highlight the new cells is to first highlight the original bundle cell (10 units of good x and 10 units of good y) and every cellbelow in the same column. After the respective cells have been highlighted in that column, the student should then highlight the cell that is down two cells and one column to the right of the original bundle cell (since the slope of the budget constraint is -2) and then highlight every cell below in the same column. This procedure should continue for all of the columns to the right of the original consumption bundle. Then, go back to the original consumption bundle and highlight the cell that is up two cells and one column to the left and then every cell below in the same column. Continue with this procedure for all of the columns to the left of the original consumption bundle. After the appropriate cells have been highlighted, as shown in Table 5, the student will see that, given the new budget, the consumer will no longer consume 10 units of good x and 10 units of good y because the consumer receives a higher level of utility by consuming 8 units of good x and 14 units of good y resulting in 114 utils of utility. Thus, the consumer has been overcompensated and thus should receive less in order to

Table 5 – Indifference Map 1: Compensating Budget Constraint to Allow Previous Consumption Bundle when $P_x = \$2$

Consumption of Good y																				
20	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400
19	19	38	57	76	95	114	133	152	171	190	209	228	247	266	285	304	323	342	361	380
18	18	36	54	72	90	108	126	144	162	180	198	216	234	252	270	288	306	324	342	360
17	17	34	51	68	85	102	119	136	153	170	187	204	221	238	255	272	289	306	323	340
16	16	32	48	64	80	96	112	128	144	160	176	192	208	224	240	256	272	288	304	320
15	15	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	285	300
14	14	28	42	56	70	84	100	114	126	140	154	168	182	196	210	224	238	252	266	280
13	13	26	39	52	65	78	91	104	117	130	143	156	169	182	195	208	221	234	247	260
12	12	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192	204	216	228	240
11	11	22	33	44	55	66	77	88	99	110	121	132	143	154	165	176	187	198	209	220
10	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
9	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135	144	153	162	171	180
8	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160
7	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
6	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
5	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
4	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
3	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
2	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Consumption of Good x

receive the same amount of utility before the price good x increased.

Because the model is discrete, there are few consumption bundles that allow the consumer to receive 100 utils of utility. If the consumer was given enough income to consume 5 units of good x and 20 units of good y, this would result in the budget constraint shown in Table 5. In order for the consumer to consume 20 units of good x and 5 units of good y, the consumer would need to be compensated above and beyond the budget constraint shown in Table 5. There is only one other combination where the consumer receives 100 utils of utility; that is consuming 7 units of good x and 14 units of good y. The process for highlighting the budget constraint would be the same as in Table 5. Highlight the cell 7 of good x and 14 of good y as well as the other cells below it in the same column. Highlight the other cells to the left and right as mentioned before using a slope of -2. The results are shown in Table 6.

The instructor may ask the students how much the consumer needs to be compensated in order to receive the same amount of utility received before the price change. One way to calculate the compensation is to ascertain the total income needed to consume 7 units of good x and 14 units of good y ($28) and subtract that from the original income ($20).

Table 6 – Indifference Map 1: Compensating Budget Constraint to Allow Previous Utility when P_X = \$2

Consumption of Good Y	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
20	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400
19	19	38	57	76	95	114	133	152	171	190	209	228	247	266	285	304	323	342	361	380
18	18	36	54	72	90	108	126	144	162	180	198	216	234	252	270	288	306	324	342	360
17	17	34	51	68	85	102	119	136	153	170	187	204	221	238	255	272	289	306	323	340
16	16	32	48	64	80	96	112	128	144	160	176	192	208	224	240	256	272	288	304	320
15	15	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	285	300
14	14	28	42	56	70	84	100	114	126	140	154	168	182	196	210	224	238	252	266	280
13	13	26	39	52	65	78	91	104	117	130	143	156	169	182	195	208	221	234	247	260
12	12	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192	204	216	228	240
11	11	22	33	44	55	66	77	88	99	110	121	132	143	154	165	176	187	198	209	220
10	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
9	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135	144	153	162	171	180
8	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160
7	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
6	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
5	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
4	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
3	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
2	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Consumption of Good X

From this point, the instructor can discuss the income and substitution effects of the price change. For this example, the substitution effect is -3 (= 7 – 10) and the income effect is -2 (= 5 – 7).[1] This way, students can see the application of the two effects rather than simply memorizing definitions.

3. Conclusion

Most (if not all) economics instructors would like their students to choose economics as their field of study and be successful. In order to adequately prepare students, they need to be familiar with the concepts that are taught in depth later in the program. Given the placement in most textbooks, consumer choice and the relation to income and substitution effects is not a major focus in a principles of microeconomics course. However, for the students who are required to take intermediate microeconomics (mostly students passionate about the field), it is beneficial if they have some exposure to indifference maps while enrolled in their principles

4 It is useful to point out to students that the negative income effect means that the good is a normal good.

Table 7 – Indifference Map 2: Inferior Good Example when P_y = \$1, Income = \$20, and P_x Inc. from \$1 to \$2

Consumption of Good y																					
20	30	102	141	170	175	180	210	240	270	300	330	360	390	420	450	480	510	540	570	600
19	29	94	130	160	165	171	200	228	257	285	314	342	371	399	428	456	485	513	542	570
18	27	89	124	154	157	162	189	216	243	270	297	324	351	378	405	432	459	486	513	540
17	26	74	101	150	151	153	179	204	230	255	281	306	332	357	383	408	434	459	485	510
16	24	67	94	119	120	144	168	192	216	240	264	288	312	336	360	384	408	432	456	480
15	23	61	90	111	113	135	158	180	203	225	248	270	293	315	338	360	383	405	428	450
14	21	55	72	103	105	126	147	168	189	210	231	252	273	294	315	336	357	378	399	420
13	20	39	59	83	98	117	137	156	176	195	215	234	254	273	293	312	332	351	371	390
12	18	36	54	73	90	108	126	144	162	180	198	216	234	252	270	288	306	324	342	360
11	17	33	50	66	83	99	116	132	149	165	182	198	215	231	248	264	281	297	314	330
10	15	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	285	300
9	14	27	41	54	68	81	95	108	122	135	149	162	176	189	203	216	230	243	257	270
8	12	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192	204	216	228	240
7	11	21	32	42	53	63	74	84	95	105	116	126	137	147	158	168	179	189	200	210
6	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135	144	153	162	171	180
5	8	15	23	30	38	45	53	60	68	75	83	90	98	105	113	120	128	135	143	150
4	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
3	5	9	14	18	23	27	32	36	41	45	50	54	59	63	68	72	77	81	86	90
2	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
1	2	3	5	6	8	9	11	12	14	15	17	18	20	21	23	24	26	27	29	30
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Consumption of Good x

of microeconomics course. Explaining indifference curves using discrete choices as opposed to continuous magnifies the model; goods can only be consumed in whole amounts. Another confusion students have stated they have had with the indifference map is that a three- dimensional model is drawn two dimensionally. Krugman and Wells (2015) draw the indifference map in three dimensions demonstrating that utility increases as consumers increase their consumption. However, when Krugman and Wells (2015) introduce the budget constraint the graph returns to two dimensions. Using the discrete indifference map shows the third dimension in a two-dimensional framework because the utility values are listed in each cell.

The instructor may cover the material by showing the discrete indifference map (Table 2) on the document camera or overhead projector, and can enhance the learning environment by making sure students have a copy in front of them. The instructor can also introduce the income and substitution effects into the model. Other indifference maps may be created that demonstrate an inferior or Giffen good. Table 7 demonstrates an indifference map for an inferior good when the income is \$20, price of good y is \$1, and the price of good x is increases from \$1 to \$2. In this case, students will see that the income effect will be positive when the price increases.

If an instructor is overly concerned that the students did not quite fully grasp the material, the instructor can reiterate these concepts when production theory is introduced. A new table could be created demonstrating the production of two goods, say good x and y. From this point, isoquants and isocost curves will be introduced and the students will see a similar approach in a different context. An instructor covering both discrete indifference curves with income and substitution effects and discrete isoquants and isocost curves will help aid students planning to enroll in intermediate microeconomics, and will improve students' understanding of how individuals and firms respond to incentives and the consequences of various policies.

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