The Journal of Private Enterprise 34(4), 2019, 99–114

EDUCATIONAL NOTE

Incentives and Economic Systems: A Classroom Exercise

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Abstract
This set of classroom simulations highlights the different incentives individuals face under economic systems defined by private property, by common property, and by a blend of the two. In each system, participants must choose how hard they will work to produce a consumption good, balancing the pleasure of consuming that good against the displeasure of work. In addition to illustrating how each economic system creates different incentives to put forth effort, the simulations can illustrate marginal reasoning, facilitate the explicit calculation of deadweight loss, and illustrate important concepts in game theory.

JEL Codes: A20, A22
Keywords: capitalism, communism, mixed economy, economic systems, classroom experiment

I. Introduction

In most introductory economics courses, students learn the three basic questions that must be answered in setting up an economic system: What is produced? How is it produced? And who receives the goods and services once they are produced? This lesson is generally followed by a discussion comparing market-based economies and command-type systems. Students enter economics courses believing that they know what capitalism and communism are and how each system impacts the individuals living within it. However, a 2016 survey by the global public opinion and data

company YouGov for the Victims of Communism Memorial Foundation, a nonprofit educational and human rights organization, shows that most Americans (especially those considered to be millennials or part of Generation Z) cannot recognize the definitions of socialism and communism; they do a better job with capitalism. Moreover, while 58 percent of the entire sample held an unfavorable view of communism, only 37 percent of millennials and 38 percent of those in Generation Z viewed communism negatively (Victims of Communism Memorial Foundation 2016).[1]

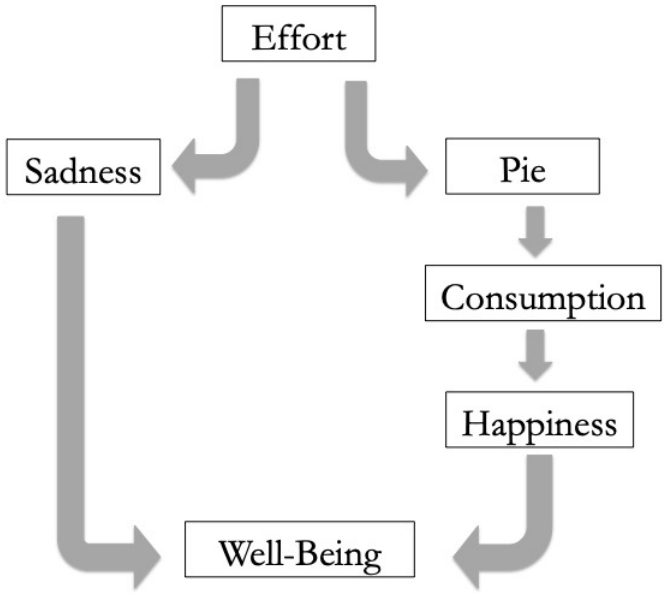
These results indicate that economists may need to do more to educate students about capitalism and communism, yet few articles in the economics literature suggest how to cover this important topic. Zygmont (2014) describes a written assignment where students must choose and read a novel based in a Soviet bloc nation and then describe how their understanding of the economics of central planning affected their reading of the book. Zygmont (2006) and McCutcheon (2015) use a series of readings about the merits of socialism and capitalism and then have their students participate in debates. To our knowledge, no published papers describe classroom experiments or simulations letting students experience firsthand the impacts of alternative economic systems on living standards. This paper fills that gap. The simulation it describes can also teach students about marginal reasoning, deadweight loss, and game theory.

II. The Model Economy

These simulations are all modeled on a single, simple economy where residents produce a single good, pie (denoted π). Completed pies are collected by a government agent, the Minister of Distribution. The Minister of Distribution, in turn, distributes all the pies to residents for consumption. In the simulation, working brings residents displeasure (denoted *sadness, S*), and consumption brings residents pleasure (denoted *happiness, H*). Participants are incentivized to maximize the net of happiness over sadness (denoted *well-being, W*). Figure 1 illustrates these key features of the economy, which are common to each simulation.

[1] In the same survey, 11 percent of millennials and 8 percent of those in Generation Z indicated that they view capitalism in an unfavorable way.

Figure 1. Key parts of the simulation



Participants in each simulation face one straightforward task: choosing the level of effort to expend producing pie. Participants may choose any effort level from zero through ten, with zero denoting no effort and ten denoting maximum effort.

A. Production

Individual production depends only on labor input and is given by $\pi_i = 25 \times E_i^{0.75}$, where π_i denotes pie produced by individual i and E_i denotes that individual's effort. This production function displays diminishing marginal returns to labor input. Overall production for the entire economy, Π, is the sum of individual production:
$\Pi = \sum \pi_i$.

B. Happiness

Individual happiness, H_i, depends only on how much pie individual i consumes, C_i. Happiness for individual i displays diminishing marginal returns to consumption. Specifically, $H_i = 5 \times C_i^{0.75}$.

C. Sadness

Individual sadness, S_i, depends only on how much effort individual i expends working to produce pie, E_i. Sadness grows exponentially

with effort. Because sadness rises as leisure falls (E_i grows), sadness can be viewed as incorporating the disutility of work along with the cost of foregone leisure. Specifically, $S_i = E_i^2$.

D. Well-Being

Well-being for individual i, W_i, is simply the difference between that individual's happiness and sadness. Specifically, $W_i = H_i - S_i$. Aggregate well-being, denoted A, is the sum of individual well-being: $A = \sum W_i$. These four essential elements—production, happiness, sadness, and well-being—are common to all of the economic systems that this set of simulations compares and contrasts.

III. Comparative Systems

The model economy outlined in section 2 is the foundation for three distinct simulations. These simulations vary only in the manner in which pie is distributed for consumption.

A. Capitalism

What exactly is capitalism? According to Merriam-Webster (2003), capitalism is "an economic system characterized by private or corporate ownership of capital goods, by investments that are determined by private decision, and by prices, production, and the distribution of goods that are determined mainly by competition in a free market." In this simulation, each participant may consume every pie he or she produces so that $C_i = \pi_i$. In this way, the simulation captures the essence of capitalism. Workers in this simulation can be viewed as worker-entrepreneurs who control both their own labor services and the capital necessary to utilize those services.

B. Communism

Communism is defined as a "theory advocating elimination of private property" resulting in "a system in which goods are owned in common and are available to all as needed" (Merriam-Webster 2003). Communism can also be thought of as "an ideology of economic equality" (Dhar 2014). In the communism simulation, a Minister of Distribution collects the pie produced by each participant. Then, the minister divides the total production equally and allocates each participant an equal share. For a group of n participants, individual i's consumption is given by: $C_i = (1/n) \times \sum \pi_i$. In this way, the simulation captures the essence of communism in that each worker owns an equal share of society's production.

C. Mixed Economy

A mixed economy is a blend of capitalism and communism. Our simulation represents a mix where the government (through the Minister of Distribution) collects part of the workers' output for equal redistribution, but the workers also get to keep some of their individual production for themselves. In the mixed-economy simulation, the Minister of Distribution collects 20 percent of the pie produced by each participant. Then, the minister divides the pie collected by the number of participants and allocates each participant an equal share. For a group of n participants, individual i's consumption is given by $C_i = 0.8 \times \pi_i + (1/n) \times 0.2 \times \sum \pi_i$.

IV. Choosing Effort Level

The participants' ideal choice of effort level depends critically on the allocation scheme chosen by the Minister of Distribution. Students can use the formulas given above to solve for their highest returns.

A. Capitalism

Participants can most easily find the ideal effort level in the capitalism simulation. To illustrate, table 1 maps out the range of possible effort levels and the well-being corresponding to each.

Table 1: Well-being across effort levels with capitalism

Effort	Production	Consumption	Happiness	Sadness	Well-being
0	0	0	0	0	0
1	25	25	55.90	1	54.90
2	42.04	42.04	82.55	4	78.55
3	56.98	56.9	103.70	9	94.70
4	70.71	70.71	121.92	16	105.92
5	83.59	83.59	138.22	25	113.22
6	95.84	95.84	153.15	36	117.15
7	107.58	107.58	167.02	49	118.02
8	118.92	118.92	180.05	64	116.05
9	129.90	129.90	192.39	81	111.39
10	140.58	140.58	204.13	100	104.13

For the capitalism simulation, a single effort level maximizes well-being: participants should each choose an effort level of 7. The corresponding level of well-being is 118.02.

B. Communism

Determining the ideal effort level in the communism simulation is not as straightforward. In the communism simulation, a participant's well-being depends not only on his or her chosen effort level, but also on the other participants' efforts. Effort expended by others produces pie that the participant shares in, creating happiness with no corresponding sadness and allowing individuals to free ride on the work of others. But, participants are often uncertain how much pie the others will generate. It may prove worthwhile for participants to determine their best strategy under a variety of possibilities. For example, a participant may attempt to determine his or her optimal effort level under the assumption that others in the simulation will all choose an effort level of 7. Then, the participant may recalculate his or her optimal effort level under the assumption that others will all choose a different effort level.

To illustrate, let's assume that there are twenty participants. Each participant receives one-twentieth of the aggregate pie production for personal consumption. Suppose that a particular individual, Karl, believes that all other participants will exert an effort level of 7. Table 2 shows aggregate the pie production and Karl's pie allocation as a function of Karl's output level.

Table 2. Karl's pie consumption under communism if all others exert $E = 7$

Karl's effort level	Karl's pie production	Others' pie production	Total pie production	Karl's pie allocation for consumption
0	0.00	2,044.17	2,044.17	102.20
1	25.00	2,044.17	2,069.17	103.45
2	42.04	2,044.17	2,086.21	104.30
3	56.98	2,044.17	2,101.15	105.00
4	70.70	2,044.17	2,114.88	105.74
5	83.59	2,044.17	2,127.70	106.38
6	95.84	2,044.17	2,140.00	107.00
7	107.58	2,044.17	2,151.75	107.58
8	118.92	2,044.17	2,163.09	108.10
9	129.90	2,044.17	2,174.07	108.70
10	140.58	2,044.17	2,184.75	109.23

Table 3, in turn, evaluates the well-being Karl receives at various expenditures of effort.

Table 3. Karl's well-being under communism if all others exert $E = 7$

Karl's effort level	Karl's pie allocation for consumption	Karl's happiness	Karl's sadness	Karl's well-being
0	102.20	160.72	0	160.72
1	103.45	162.10	1	161.19
2	104.31	163.19	4	159.10
3	105.05	164.07	9	155.07
4	105.74	164.87	16	148.87
5	106.30	165.60	25	140.6
6	107.00	166.34	36	130.34
7	107.58	167.00	49	118.00
8	108.15	167.60	64	103.68
9	108.70	168.32	81	87.32
10	109.23	168.94	100	68.94

If Karl believes every other worker will expend seven units of effort, Karl can maximize his own well-being by expending only one unit of effort. In other words, Karl will work dramatically less than he did when he kept the entire product of his effort.

What if Karl, recognizing his own incentive to expend little effort, also believes others will expend little effort? Suppose Karl believes that the other nineteen participants will choose an effort level of 1. Table 4 shows the well-being Karl can expect to receive for various choices about his own effort.

Notice that again, Karl's optimal strategy is to choose an effort level of 1. At higher levels of effort, Karl's well-being becomes negative: his coworkers' low effort and production generate little happiness for him, while the high effort he expends brings him considerable sadness.

Tables 2 through 4 show that, across a wide range of his coworkers' effort choices, Karl's best strategy is to expend one unit of effort. For twenty workers total, in fact, that effort level is an equilibrium. For larger groups (specifically, for groups larger than 213), the ideal effort level is zero rather than one because an individual worker bears all of the cost of work, but shares the

benefits equally with all of the others, leaving the individual worker with very little pie, regardless of their effort level.

Table 4. Karl's well-being under communism if all others exert $E = 1$

Karl's effort level	Karl's pie production	Others' pie production	Total pie production	Karl's pie allocation for consumption	Karl's happiness	Karl's sadness	Karl's well-being
0	0.00	475	475.00	23.75	53.79	0	53.79
1	25.00	475	500.00	25.00	55.90	1	54.90
2	42.04	475	517.04	25.85	57.32	4	53.30
3	56.98	475	531.98	26.59	58.56	9	49.56
4	70.71	475	545.71	27.20	59.69	16	43.60
5	83.59	475	558.59	27.92	60.70	25	35.74
6	95.84	475	570.84	28.54	61.74	36	25.74
7	107.58	475	582.58	29.12	62.69	49	13.69
8	118.92	475	593.92	29.69	63.60	64	–0.39
9	129.90	475	604.90	30.24	64.48	81	–16.51
10	140.58	475	615.58	30.77	65.33	100	–34.66

C. Mixed Economy

What if a worker captures most, but not all, of the product of his or her efforts? Consider a mixed economy in which the Minister of Distribution collects one-fifth (20 percent) of each person's production, and then allocates the pie collected equally to all workers. In this case, the ideal choice of effort level may again depend on the behavior of one's coworkers.

Suppose that a worker in this economy, Carla, believes that the other workers will choose an effort level of seven, which you may recall was ideal in the capitalism simulation. Table 5 shows Carla's expected well-being versus her own choice of effort:

Carla's optimal effort expenditure, six units, is between what is ideal for her under capitalism (seven units) and under communism (one unit). So taxes, even when the proceeds are all returned to the workers in the form of benefits, discourage work effort. This effort is largely invariant across the choices made by other workers because the pie is spread across all participants equally; even if the others each choose to expend only one unit of effort, Carla's optimal effort level remains six units. In fact, for this number of workers, six units is an equilibrium choice.

Table 5. Carla's well-being under the mixed economy if all others exert $E = 7$

Carla's effort level	Carla's pie production	Others' pie production	Pie collected by government	Carla's consumption	Carla's happiness	Carla's sadness	Carla's well-being
0	0.00	2,044.17	408.83	20.44	48.06	0	48.06
1	25.00	2,044.17	413.83	40.69	80.55	1	79.55
2	42.04	2,044.17	417.24	54.49	100.20	4	96.28
3	56.98	2,044.17	420.23	66.60	116.56	9	107.56
4	70.71	2,044.17	422.90	77.717	130.87	16	114.87
5	83.59	2,044.17	425.55	88.15	143.84	25	118.84
6	95.84	2,044.17	428.00	98.07	155.82	36	119.82
7	107.58	2,044.17	430.35	107.58	167.02	49	118.02
8	118.92	2,044.17	432.61	116.70	177.60	64	113.60
9	129.90	2,044.17	434.81	125.66	187.66	81	106.66
10	140.58	2,044.17	436.95	134.31	197.27	100	97.27

V. Discussion Points

These simulations can illustrate a number of concepts commonly taught in both the micro and macro principles courses. Those concepts include marginal reasoning and deadweight loss.

A. Marginal Reasoning

Many students have a difficult time understanding how to use marginal reasoning to identify optimal behavior. The capitalism portion of this simulation provides instructors an ideal platform for exploring that idea. Beginning with an effort level of zero, each additional (or marginal) expenditure of effort brings both costs (sadness) and benefits (more pie, which in turn creates more happiness). Table 6 shows both total and marginal quantities for both sadness and happiness.

Table 6. Measuring marginal happiness and marginal sadness under capitalism

Effort	Production and consumption	Total happiness	Total sadness	Marginal happiness	Marginal sadness	Well-being
0	0.00	0.00	0	—	—	0.00
1	25.00	55.90	1	55.90	1	54.90
2	42.04	82.55	4	26.65	3	78.55
3	56.98	103.70	9	21.14	5	94.70
4	70.71	121.92	16	18.21	7	105.92
5	83.59	138.22	25	16.30	9	113.22
6	95.84	153.15	36	14.92	11	117.15
7	107.58	167.02	49	13.87	13	118.02
8	118.92	180.05	64	13.02	15	116.05
9	129.90	192.39	81	12.33	17	111.39
10	140.58	204.13	100	11.74	19	104.13

Recall that the ideal level of effort expenditure in the capitalism simulation is seven units. Those seven units of effort create 118 units of well-being. Students can feel their way to that optimal solution by comparing the marginal happiness and marginal sadness of additional effort. If the marginal happiness of more effort eclipses the marginal sadness, well-being will improve with effort; the range of effort levels where this happens are shaded light gray. However, if the marginal happiness created by more effort is outweighed by the marginal sadness that effort creates, the effort will reduce well-being. The range of effort over which this happens is shaded dark gray. The ideal effort level is where the marginal benefits (happiness) and marginal costs (sadness) are equal. (Note that here, we do not have perfect equality because of the discrete levels of effort available, but that equality occurs somewhere between seven and eight units of effort.)

B. Deadweight Loss

This set of simulations is also a convenient vehicle for measuring deadweight loss. Under capitalism, each of twenty workers ideally chooses seven units of effort. Individual well-being is approximately 118.02; aggregate well-being is twenty times that, or 2,360.40.

Under communism (table 4), each worker's ideal choice of effort falls from seven units to one unit. This decline in effort causes individual production to fall from 107.58 to 25.00. That drop, in and

of itself, does not indicate deadweight loss; it is possible that working less could make someone better off. Rather, we are interested in the change in aggregate well-being that results when we hypothetically switch regimes from capitalism to communism. Under communism, if each worker expends one unit of effort, individual well-being becomes 54.90; aggregate well-being is twenty times that, or 1,098. So, communism creates 1,262 (2,360 – 1,098) fewer units of well-being than capitalism. We can call this difference the deadweight loss of communism.[2]

Similarly, we can calculate the deadweight loss of a mixed economy. Even the relatively mild 20 percent tax, which is coupled with a complete and equitable redistribution, creates a deadweight loss as workers each cut their effort from capitalism's seven units to the mixed economy's six units. That effort level corresponds to an individual well-being of 117.16 and aggregate well-being of 2,343.20, for a deadweight loss of seventeen units of well-being (2,360 – 2,343).

C. Concepts in Game Theory

This set of three simulations illustrates important fundamental concepts in game theory. First, for any particular participant in the capitalism simulation, the ultimate outcome is independent of other participants' chosen effort levels. In other words, determining the ideal effort level under capitalism constitutes a decision, rather than a game. In contrast, in the communism and mixed-economy simulations, the ultimate outcome depends not only on what effort level the individual participant chooses, but also on the effort levels the other participants choose. This mutual interdependence is a fundamental feature of an economic game.

The communism simulation can also illustrate the concepts of dominance, dominance solvability, and Nash equilibrium. Recall that in that simulation as illustrated (with formulas as given and twenty participants), model participant Karl's ideal effort level was one unit of effort. That turned out to be the best strategy for Karl regardless of the effort level chosen by the other participants. In other words, in the communism simulation, one unit of effort was a dominant

[2] This deadweight loss to communism reflects only the lost efforts as a result of the incentives to shirk. This is separate from the deadweight loss to central planning, which results from the inability of planners to know what and how much to provide to their citizens. In addition, we've assumed that all pie collected is returned to the citizens. In real life, it is likely that government officials will keep some pie for themselves.

strategy for Karl. Furthermore, because everyone faces the same incentives, expending one unit of effort was the best strategy for all other participants. So the theoretical solution to this economic game, where all participants exert one unit of effort, is found at the intersection of everyone's dominant strategies. When all participants expend one unit of effort, none can improve their outcome by altering their effort level; one unit of effort turns out to be a Nash equilibrium in the communism simulation (for all $n < 214$ because the amount of pie the participants receive is so small that their happiness is outweighed by the sadness from working).

The communism simulation clearly illustrates the fundamental characteristics of an *n*-player prisoner's dilemma game. The characteristics of the prisoner's dilemma (see, for example, Grant 2016) are as follows: Players can either cooperate or defect; defect is a dominant strategy; there is a single Nash equilibrium where all players defect; that dominant strategy equilibrium is worse for the group collectively and individually than the outcome in which all players cooperate.

In the communism simulation, participants can cooperate (work hard) to produce a large economic pie with correspondingly large individual well-being, or they can defect (expend little effort). But expending little effort dominates working hard—given the simulation as illustrated above, an effort level of 1 dominates all other effort levels. The equilibrium outcome, in which all players expend one unit of effort, produces lower individual and collective well-being than the outcome in which all players cooperate and expend seven units of effort.

D. Economic Calculation

This simulation focuses on the effects of the economic system on workers' incentives to produce. There are other important differences that the instructor may want to discuss with students. One is the resource misallocations that occur in centrally planned economies because central planners have neither the information nor the calculating power to make efficient choices when planning production (Mises 1990). In contrast, a well-functioning price system tends to make efficient choices over resource allocation unless goods are nonrival or nonexclusive.

VI. Implementation and Scoring

Not every economics textbook has a section that covers this material. Thus, the instructor may need to provide students with additional readings or videos. The instructor can provide students with background about each type of system and its key features. With capitalism, the instructor can focus on the private ownership of resources, decentralized planning and production through the market system, and the link between effort and reward. With communism, the instructor may wish to discuss central planning of production, state control of productive resources, lack of private property, and equal distribution of the output. The mixed system combines both of these systems. Some economies fall closer to pure capitalism, while others are more communistic.

These simulations can be performed in sequential class periods or over a few weeks, depending on how the instructor chooses to combine them with the other course material. It is best, however, if students are given the instructions before the class period where the students will be doing the simulation so that they can practice with the formulas and determine their best options under the different scenarios.

Student responses in these simulations can be obtained either by devices (clickers or cell phones) or by paper. The most important part of this collection is that the students don't know each other's responses. The capitalism simulation can be run in one round; there is only one answer that maximizes the student's well-being. The other two simulations require more than one round. In general, the authors use two to four rounds of each.

In the communism simulation, most students will begin by working a little. But, they will see that they will receive little pie (less than they themselves produce), and this realization will discourage them from working in future rounds. More students will choose to exert zero effort over time. The mixed-economy simulation generally takes fewer rounds, and students are more likely to be satisfied with the outcome.

After each round, devote some time to discussing the results. Instructors should ask the students about the choices they made and why. In the communism and mixed-economy simulations, students should discuss how their choices evolved over the different rounds. Instructors should focus the discussion on the incentives built into each system. At the end of the three simulations, students can discuss

how their levels of well-being varied across the different economic systems, ranking the outcomes.

VII. Possible Extensions to the Simulation

These three exercises provide a simple way of demonstrating the impact of economic systems on workers' incentives to put forth effort. They were devised to be simple to make them easy for instructors to use in their courses and to ensure that students can perform the calculations necessary to optimize their decisions. However, there are several ways in which the instructor may extend these simulations to include more "real-world" characteristics. First, students can be assigned production functions that differ, allowing for differences in productivity. This could mean changing the coefficient or the exponent, but care should be taken to ensure that each student faces diminishing marginal productivity.

Second, students could be given different utility functions by altering their happiness (H_i) equation. In the real world, some individuals are more materialistic than others; having different functions can reflect this.[3]

Third, all mixed economies are not alike in the real world. Therefore, the mixed-economy simulation can also be reconsidered by selecting a different tax rate. This change will allow students to see how individuals in different countries may optimize their productive efforts. At minimum, students will see how the deadweight loss will vary with the tax rate. The instructor may also want to discuss how the economic calculation problem becomes more difficult as the tax rate rises.

Fourth, it may be fun to include the provision of a public good in the model of the mixed economy. For example, the instructor could follow an experiment such as that suggested by Holt and Laury (1997), where the collection of pies by the Minister of Distribution is multiplied by some value before being redistributed to the citizens equally. This allows the workers to receive some sort of return on the taxes they have paid in. Of course, the improvement in the citizens' overall welfare must be tempered by the economic calculation problem. While the government can possibly improve welfare by providing a public good, it is difficult for the government to know what public goods to produce and in what amounts.

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[3] Of course, the fact that students have different preferences for working hard for a grade is already implicitly built into the classroom simulation. Those who care a great deal about their grades will work to maximize their economic well-being.

Last, if the instructor wants to allow students to see the difficulties of the economic calculation problem faced by central planners, we suggest this possible extension. The calculation problem arises because the central planner lacks the knowledge to properly allocate resources. In this extension, students can proxy for the central planner by making their optimization decision in the absence of complete information. Specifically, the instructor can begin the series of simulations by withholding their production, happiness, and sadness functions; each student chooses an effort level and then observes the resulting happiness. Then, the instructor can implement the capitalism simulation with full information to show what was possible. The difference in overall well-being between these simulations can be referred to as a proxy for the deadweight loss of central planning.

VIII. Concluding Remarks

Classroom simulations are generally believed to improve student understanding of economics (Emerson and English 2016). This paper provides a three-part classroom experiment that demonstrates how incentives and well-being differ between three economic systems: capitalism, communism, and the mixed economy. In addition, these simulations give students an opportunity to practice marginal analysis, compute deadweight loss, and understand game theory concepts such as the Nash equilibrium.

It is important in this day and age to educate students about these economic systems, as there appear to be major misunderstandings about the effects of these systems on individuals' well-being and lives. Experiencing the impacts of the systems on their own individual incentives and well-being allows the students to see for themselves that the rules of the game have important implications for their lives.

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