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Teaching Production with SimCity BuildIt

This article presents an alternative way to introduce topics in production that are commonly taught in introductory economics using a popular mobile game called SimCity BuildIt. The author focuses on the topics of production possibility, opportunity cost, firm production, and cost structure. The article shows how elements in the game can be used to motivate the learning of these topics. Specific examples for each topic can also be generated from the game to be used to introduce the topic and as assignments for students. This allows students to incorporate their gaming experience with learning economics.

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1. Introduction

Video games have become prominent among college students, especially in recent years. With the popularization of smartphones, various video games with online components are easily available for download from any app store. Most of them are free to download, but they come with optional in-app purchases and intrusive advertisements. Since video games are designed to attract the attention and interest of students, there is a potential for educators to utilize these games to keep students engaged in the classroom. The game introduced in this paper is SimCity BuiltIt, which is a simulation game. Simulation games are a category of video games that are generally designed to closely simulate real world activities. SimCity BuiltIt is designed to simulate the experience and role of a mayor in developing a city.

The benefits and effectiveness of video games in education have been well documented.[1] Sitzmann (2011) and Vogel et al. (2006) provide meta-analytic evidence of improvement in cognitive learning outcomes from simulation games relative to traditional instructional methods. The effectiveness of these games in learning and retention of knowledge has also been found in Wong et al. (2007) and Wouters et al. (2013). Coller & Scott (2009) found that students in video game-based classes spend twice as much time outside of the classroom on coursework. Similar studies have also been done regarding the effectiveness of games in economics and finance education. Gremmen & Potters (1997) found that students who played a macroeconomic game called SIER (simulating international economic relations) scored better in a series of multiple-choice tests than those taught the same model in a traditional lecture. Dobrescu et al. (2019) found similar results in student learning of comparative statics. The most recent study by Kalmi & Rahko (2022) also found robust effects concerning knowledge gained from game-based financial education in lower secondary schools in Finland.

Mayer (2014) presented a more robust cognitive theory outlining five cognitive processes of multimedia learning: selecting relevant words from the presented text or narration, selecting relevant images from the presented graphics, organizing the selected words into a coherent verbal representation, organizing selected images into a coherent pictorial representation, and integrating the pictorial and verbal representations and prior knowledge. Incorporating video games in educational environments predominantly seeks to achieve the last cognitive process.

In light of the evidence on the effectiveness of video games in education, there have been many methodology developments on the incorporation of video games in economic teaching. The majority of the methodological developments are in college-level introductory economics. Rogmans (2018) introduces the incorporation of Econland in introductory macroeconomics. Econland is an instructional game developed by Sim Institute in which the player has to decide on monetary and fiscal policies to keep the population of an economy satisfied through a seven-year business cycle. Vidal (2020) outlines how Civilization IV can be used to teach various concepts in macroeconomics, including labor, capital, technology, and economic growth. Mateer & O'Roark (2020) use Animal Crossing, another popular video game, to derive various economic lessons.

Some economics instructors even develop their own games to supplement their teaching. Lawson & Lawson (2010) provided an outline on how to develop a successful

[1] An overview on the effectiveness of video game application in education can be found in Alshammari et al. (2015) and Egenfeldt-Nielsen (2006)

instructional video game for economic teaching. Ng (2019) developed a video game with 8 modules to supplement the teaching of hybrid introductory microeconomics. Woltjer (2005) developed a game called Steer the Economy to simulate the workings of production in the macroeconomy. Each player in the game manages a single firm in the economy. The interactions among the players then generate fluctuations in unemployment, inflation, real wages, and investment. There are also games developed to introduce specific topics in introductory economics. Youngberg (2019) developed Merchants of the Sea for students to practice the understanding of comparative statics in the demand and supply framework. Fabian (2021) introduces a PowerPoint-based game called DevSim to teach the allocations of capital and labor in developmental economics.

This article intends to contribute towards the expansion of ideas in incorporating video games in economic teaching. The author introduces the use of a popular simulation game called SimCity BuildIt to teach introductory economics. The focus is on the topics surrounding production including production possibility, opportunity cost, production function, and cost structure that are typically included in standard curricula for introductory economics. The author explains in detail a specific example that is used in class to introduce each of these topics. Discussion includes how similar examples can be generated from the game for use in lectures, classroom activities, and assignments.

This article also contributes to the innovation of alternative methods in teaching topics in production, such as the introduction of classroom experiments to illustrate the concept of marginal cost (Bernard & Schulze (2000)) and production possibility (Carson & Tsigaris (2011)), the incorporation of experiences from World War II in teaching production possibility (Kyer & Maggs (2021)), and the visualization of the long-run average cost using an interactive excel module (Mitchell (2009)).

The paper is organized in the following manner. Section 2 gives an overview of SimCity BuildIt. Section 3 explains how SimCity BuildIt can be used to introduce production possibility and opportunity cost. Section 4 explains how it can be used to introduce firm production and cost structure. Section 5 explains the logistics of implementing the game in courses. Section 6 describes other topics that can also be introduced using the game. The sample classroom activities that the author designed can be found in the Appendix.

2. An Overview of SimCity BuildIt

SimCity BuildIt is an open-ended city-building simulation mobile game. It was launched in 2014 by Electronic Arts and is part of the SimCity franchise. The game is available to download for free on Apple, Android, and Amazon app stores. SimCity BuildIt has over 100 million downloads and over 5 million reviews on Google Play. It is the most played game under the SimCity franchise. Although it comes with intrusive advertisements and inapp purchases, students are still able to fully participate in all class activities and materials presented in this article without paying anything. The game can be downloaded and played on any smartphone or tablet, which should not present any barrier for students.

The player of SimCity BuildIt acts as the mayor of the city. The main goal of the mayor is to build and expand the city while keeping the population happy. Figure 1 is a screenshot of the gaming environment. It shows that the city is at level 32 with a population of 271,813 and an overall happiness of 100%. The city also currently has a reserve of 111,981 Simoleons, which is the currency of the game.

The construction and upgrades of residential buildings are the only way the population of the city can grow. They also produce experience points that lead to increases in the level of the city. The happiness of the population of the city is influenced by various factors. The availability of public amenities such as parks, schools, fire departments, and hospitals has a positive effect on happiness. Pollution from factories, power plants, and sewage facilities has a negative effect on happiness. As the mayor of the city, the player can earn Simoleans from collecting taxes from the population. The amount of tax that can be collected each day is a function of the happiness and the size of the population. Simoleans can also be earned from construction and upgrades of residential buildings.

The development of the city is supported by five categories of construction: roads, residential buildings, commercial buildings, industrial buildings, and services. These five categories of construction are represented by the five icons on the bottom right of Figure 1.

Roads. The only purpose of roads is to connect buildings and services. Any construction not connected to a road is non-functional.

Residential Buildings. To expand the city, more residential buildings have to be built. The construction and upgrades of residential buildings require items produced from commercial and industrial buildings. Pending construction and upgrades of residential buildings are represented by a yellow hat as labeled in Figure 1.

Figure 1. SimCity BuildIt Gaming Environment

Commercial Buildings. The production of items that are eventually used to construct and upgrade residential buildings takes place in commercial buildings. These productions require raw materials produced in industrial buildings and/or items produced from other commercial buildings. The production of items does not require any Simoleons, but they take time. Some examples of commercial buildings include building supplies stores,

hardware stores, farmer's markets, furniture stores, and gardening supplies stores. The construction of commercial buildings requires Simoleons. Production in commercial buildings runs in series. A commercial building has to complete the production of one item before the production of the next item in line can begin.

Industrial Buildings. Industrial buildings produce raw materials that are needed for the production of items in commercial buildings. Some examples of raw materials are metal, wood, plastic, seeds, and glass. The production of raw materials does not cost any Simoleons, but it takes time. The types of industrial buildings include small factories, basic factories, mass-production factories, and high-tech factories, each of which has a different number of production slots and pollution size. The construction of industrial buildings requires Simoleons. In contrast to production in commercial buildings, production in industrial buildings runs in parallel. For example, a metal takes one minute to produce and a basic factory has three production slots. This implies that a basic factory can produce three metals within one minute.

Services. Services are structures built to provide a specific amenity such as power, water, sewage, police, health, fire, and waste management. There are specific requirements for each of the services provided by the city. These requirements have to be satisfied to maintain a larger and happier population in the city.

In order to build industrial buildings, commercial buildings, and services that require Simoleons, the city has to collect taxes. The amount of tax that the city is able to collect each day is a function of the overall happiness and the size of the population, which can be found by clicking on the City Hall. As the overall happiness of the population goes down, the tax revenue that the city is able to collect decreases, which reduces the ability of the mayor to provide services to the population. This further decreases the happiness of the population.

3. Production Possibility

SimCity BuildIt requires the player to run various productions in order to expand the city and progress in levels. These productions can be split into two categories: the production of raw materials in industrial buildings and the production of items in commercial buildings. In this section, two examples are introduced, one from each production category that are used to introduce the concepts of production possibility and opportunity cost to students.

Production of Raw Materials

Using an example from the production of raw materials to introduce production possibility is straightforward since it does not require any inputs. However, the player has to wait

Table 1. List of Industrial Buildings

Industrial Building	Price	Population Required	Production Slots
Small Factory	Free	None	2
Basic Factory	500 Simoleons	4,000	3
Mass Production Factory	7,000 Simoleons	27,000	4
High-tech Factory	20,000 Simoleons	80,000	5
Nano-tech Factory	50,000 Simoleons	150,000	5

Figure 2. Information on Mass Production Factory

Table 2. List of Raw Materials

Raw Material	Production Time	Levels Required
Metal	1 minute	1
Wood	3 minutes	2
Plastic	9 minutes	5
Seeds	20 minutes	7
Minerals	30 minutes	11
Chemicals	2 hours	13
Textiles	3 hours	15
Sugar and Spices	4 hours	17
Glass	5 hours	19
Animal Feed	6 hours	23
Electrical Components	7 hours	29

a specific amount of time for each production to be completed. Table 1 lists the types of industrial buildings together with the price of the building, the population size the city has to reach to unlock the building, and the number of production slots the building has. Figure 2 shows where in the game the information of a particular iindustrial building can be found. According to the information shown, a mass production factory has four production slots and costs 7,000 Simoleons to build. The player can only build mass production factories after the city has at least a population of 27,000.

Any industrial building is able to produce all types of raw materials. The list of raw materials is presented in Table 2, together with their production times and the levels the player has to reach in order to start producing them. Figure 3 shows a small factory with two production slots. It also shows the production times for metal, wood, plastic, and seeds, which can be obtained by clicking on each of the raw materials available for production.

The production possibility at the introductory level typically involves the production of two goods, which can fit into a two-dimensional diagram for visualization. The amount of resources available should also be well defined. Given the information in Tables 1 and 2 extracted from the game, instructors can potentially pick any two raw materials, any combination of industrial buildings, and any amount of time allocated for production to

Figure 3. Information on Raw Materials

introduce production possibility. The industrial buildings and time allocated for production then define the resources available to construct the production possibility.

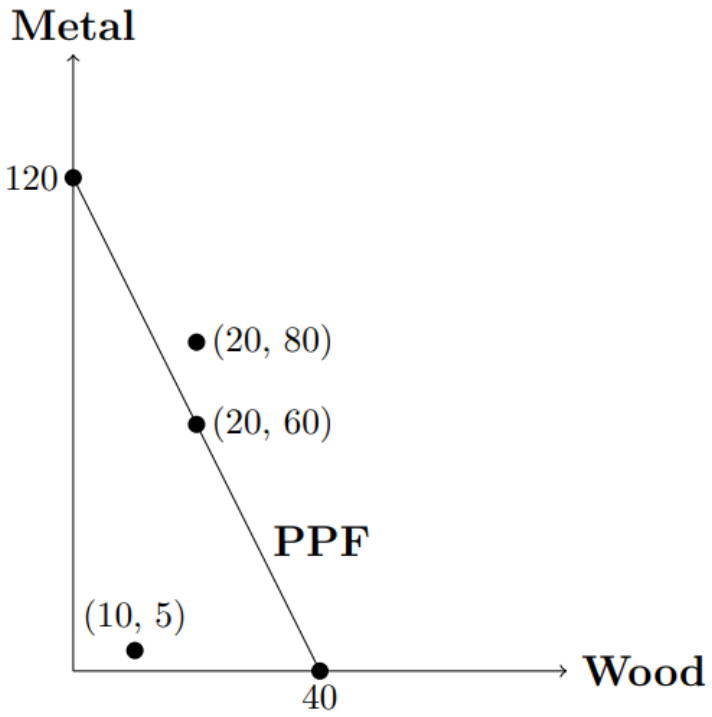
For example, how many seeds and textiles can two basic factories and three mass production factories produce in four hours? How many minerals and chemicals can three high-tech factories, five basic factories, and two small factories produce in five hours? Instructors can select as many factories as they want and pick any amount of time allocated for production. However, the number of items produced has to be limited to two to keep the production possibility frontier two-dimensional.

A. Production Possibility Frontier

In class, the author uses the simplest possible example that involves the production of metal and wood with only one small factory within an hour. This example minimizes the time students have to spend playing the game to unlock the necessary features.

Since each metal takes one minute to produce, if one production slot is allocated solely to produce metals, 60 metals can be produced in an hour. With two production slots in the small factory, 120 metals can be produced if the entire hour for both slots is allocated to

Figure 4. Production Possibility Frontier (PPF)



metal production. Similarly, if the entire hour for both slots is allocated to wood production, 40 woods can be produced. The production possibility frontier can then be constructed, as presented in Figure 4.

It is explained to students that there are two key assumptions that have to be made for the production possibility frontier in Figure 4 to make sense. First, the production possibility frontier is linear. This is because the amount of time required for the production of each metal and each wood is constant regardless of how many metals and woods are produced. This is true by the construction of the game, which is often not the case in real-life productions.

Second, it is assumed that there is no lag between productions. In practice, once a production slot completes a production, the player has to initiate the production of the next material in the slot. It usually takes a few seconds for the transition between productions, that is if the player happens to be on the game while the previous production finishes.

Otherwise, the lag time can be significantly longer. The production possibility frontier in Figure 4 assumes that such lags do not exist.

This is also a good time to discuss what information the production possibility frontier can provide. Any production combinations below the frontier are possible but inefficient. This includes ten woods and five metals as shown in Figure 4. Any combinations on the frontier are possible and efficient, such as 20 woods and 60 metals. Any combinations above the frontier are not possible, such as 20 woods and 80 metals. It is also important to inform students that even though any combinations on the frontier are efficient, the frontier does not provide sufficient information about which combination should be produced.

B. Opportunity Cost

In the standard introductory economics curriculum, the next step is to calculate the opportunity costs. Since each metal takes one minute and each wood takes three minutes, the opportunity cost of producing one metal is 1/3 woods and the opportunity cost of producing one wood is three metals. In this two-goods example, the opportunity cost of producing one good is the inverse of the opportunity cost of producing the other good.

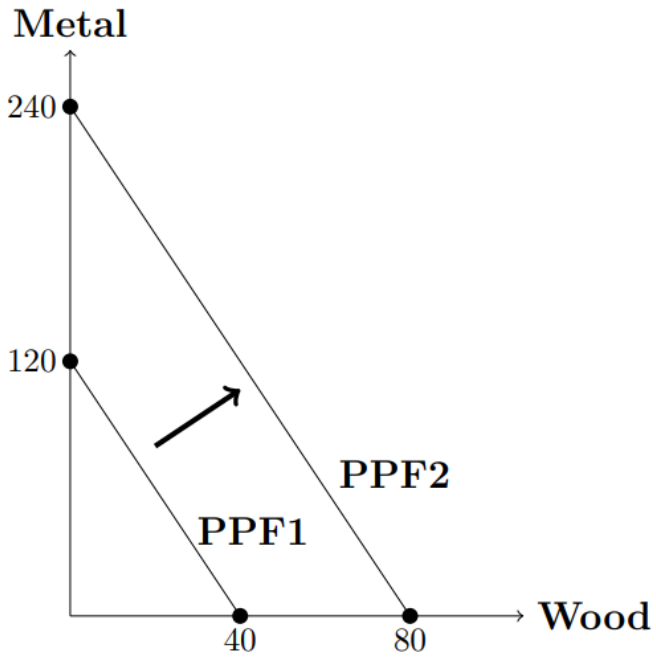
Opportunity costs can also be related to the slope of the production possibility frontier in Figure 4. The slope of the PPF is negative of the opportunity cost of the good on the horizontal axis. Since the opportunity cost of producing one wood is three metals, the slope of the PPF is -3.

C. Economic Growth

Economic growth can be explained in the context of SimCity BuildIt as the construction of additional industrial buildings (accumulation of physical capital) and/or an increase in the amount of allocated time (expansion of labor force).

In the example the author introduced, if the city builds an additional small factory, the total number of production slots becomes four. The city is then able to produce 240 metals or 80 woods if it allocates all its available resources to the production of metal or wood, respectively. An increase in the allocated time from one hour to two hours has the same effect on the production capacity of the city. It causes a shift of the production possibility frontier to the right, as shown in Figure 5 from PPF1 to PPF2.

Figure 5. Effect of Economic Growth on PPF



It is important to indicate to students that the slope of the production possibility frontier does not change. The growth from one to two small factories or one hour to two hours of allocated production time is represented by a parallel shift of the frontier up and to the right. This is because the production times for both metal and wood remain the same, and so do the opportunity costs.

The same idea can be applied to the opposite scenario in which the number of industrial buildings or the amount of allocated time decreases. This can be caused by a war or a natural disaster, both of which are part of the game. Club War is unlocked at level 18 and the Vu Tower which causes various natural disasters is unlocked at a population of 90,000. In this case, there is a parallel shift of the production possibility frontier down and to the left.

D. Technological Advancement

Technological advancement in the context of SimCity BuildIt can be explained as the application of speed-up tokens. As shown in Figure 6, speed-up tokens can be obtained by completing the epic projects assigned by the Department of Epic Projects, which is unlocked

Figure 6. Department of Epic Projects

Figure 7. Turtle Speed-Up Token

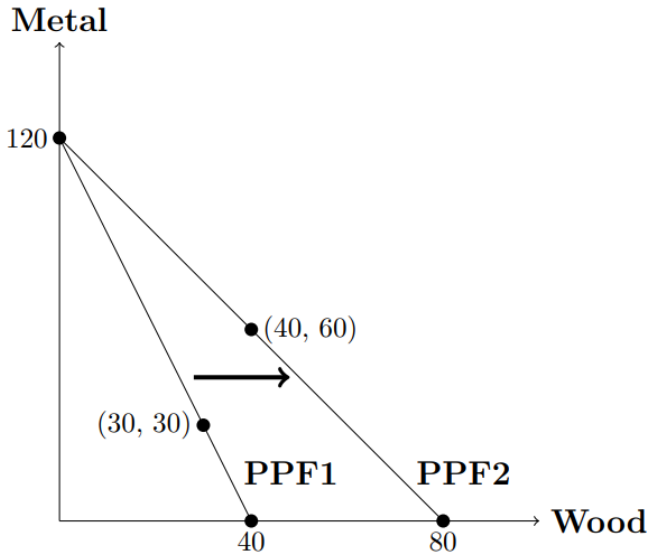
at level 16. Speed-up tokens decrease the production times of items. Even though speedup tokens can only be used at commercial buildings in the game, and once it's used on a commercial building it applies to the production of all items in the building, the idea can be transferred to the production of one raw material in an industrial building. Figure 7 shows one of the three available types of speed-up tokens available in the game. The turtle speed-up token lasts for one hour and makes production twice as fast.

If a turtle speed-up token is applied to the production of woods, which is analogous to a technological advancement in the production of wood that makes its production twice as fast. Each wood now takes 1.5 minutes to produce. The maximum quantity of woods that can be produced increases from 40 to 80. The maximum quantity of metals that can be produced stays at 120. The production possibility frontier rotates from PPF1 to PPF2 as shown in Figure 8. The expansion of the area that represents the combinations of metals and woods that are possible for the economy to produce represents the economic growth generated by the technological advancement in the production of wood.

Since the slope of the production possibility frontier has changed, the opportunity costs have changed as well. The opportunity cost for producing a metal is now 1.5 woods and the opportunity cost for producing a wood is 2/3 metals.

It is also important to inform students that the application of the turtle speed-up token on the production of wood can potentially increase the production of both metal and wood. Figure 8 shows two efficient production points under PPF1 and PPF2, respectively. Before the application of the turtle speed-up token, producing 30 metals and 30 woods is efficient. After the application of the token, producing 60 metals and 40 woods is efficient. By comparing these two efficient production points, students can see that the production of metal can also increase because of the freed-up resources from the more efficient wood production. An extension can also be made after introducing technological advancement to the production of wood in one industrial building. Since the opportunity costs of this industrial building are different from other industrial buildings that did not have the speed up token

Figure 8. Effect of Technological Advancement in the Production of Wood on PPF



applied, the idea of comparative advantage and trade can be introduced.

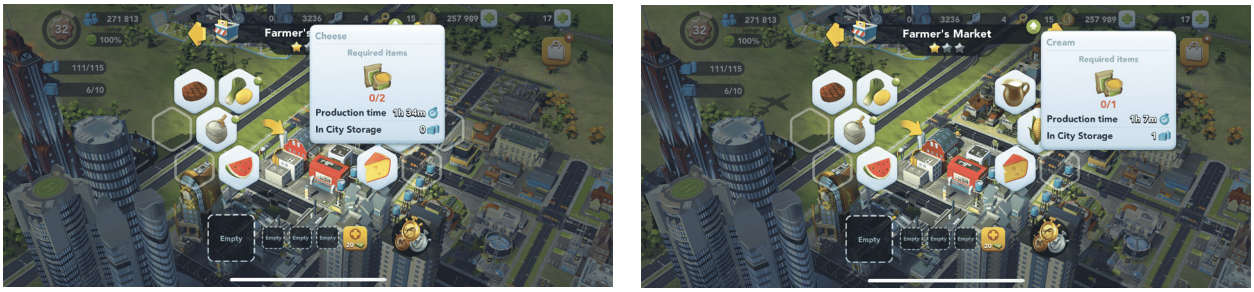
In Appendix A.1, two long questions are attached that the author wrote for one of the classroom activities. They require students to not only understand the concepts of production possibility and opportunity cost but also to harvest the necessary data from SimCity BuildIt.

Production of Items

Production of items in commercial buildings can also be used as an example to introduce production possibilities. The production of items requires both inputs and time, thus finding a sufficiently simple example for an introductory-level class can be challenging. Focusing only on inputs and ignoring the production time is recommended. Even then, the two items chosen need to have the same inputs.

The example that has the lowest level requirement is the production of cream and cheese in the Farmer's Market as shown in Figure 9. The Farmer's Market is unlocked at level 8. However, cream and cheese are unlocked at levels 23 and 25, respectively. This might be a barrier for students as they have to spend more time playing the game to arrive at those levels.

Figure 9. Productions of Cream and Cheese



Cream and cheese both require only animal feeds to produce. Animal feeds can be produced in any industrial building with a production time of six hours. The resource constraint in this example is the quantity of animal feeds available for production. Instructors can pick any given number of animal feeds available in city storage for cream and cheese productions. For example, given that the city has 120 animal feeds in storage, what are the combinations of quantities of cream and cheese that can be produced?

Economic growth in this example has to be interpreted as an increase the stock of animal feeds available in the city storage. Technological advancement involves a reduction in the quantity of animal feeds required for the production of cheese or cream.

The author highly recommends that instructors stick to the production of raw materials when introducing production possibilities to minimize the time commitment of students playing the game, but these alternative examples are possible.

4. Firm Production and Cost Structure

The production of raw materials in industrial buildings and the production of items in commercial buildings can also be used to introduce firm production and cost structure. The city can be considered as a giant "firm" that owns all the industrial buildings to produce raw materials. As the mayor of the city, the player acts as the manager of the firm deciding how many industrial buildings the city should own. The player is also able to decide the number of hours these industrial buildings should run.

To match the standard production and cost structure topics in introductory economics, there are a few restrictions that have to be made. First, the production should be limited to only one type of raw material. Second, small factories have to be eliminated as an option since they are free to build (see Table 1). Otherwise, the city can build only small factories and enjoy zero fixed costs even in the short run. Third, it is assumed that the player can hire an "assistant mayor" at an hourly rate in terms of Simoleons to help run the production in the industrial buildings. This then represents the cost of labor.

To maintain simplicity and accessibility to students, the example presented in this section assumes that the city only produces metal and owns one basic factory. In the short run, the city is able to decide how many hours of assistant mayor services (labor) it hires. The hourly wage is 200 Simoleons.[2] However, the city is stuck with one basic factory and unable to build or demolish any industrial buildings in the long run. As shown in Table 1, a basic

[2] The hourly wage is arbitrarily set. However, it should be kept comparable to the total fixed cost in order to produce reasonable numbers for the average costs.

factory costs 500 Simoleons.

Production Function

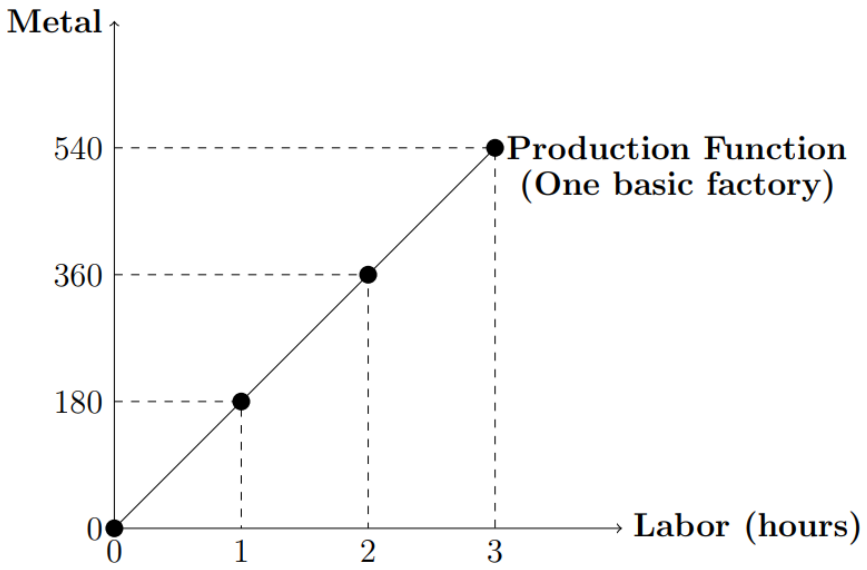
The first concept that can be introduced with this example is the production function. In the short run, the production function maps the number of labor hours hired to the quantity of metals produced. A basic factory has three production slots and each metal takes one minute to produce. Therefore, each hour of labor hired can produce 180 metals. The production function in table and graph formats are presented in Table 3 and Figure 10, respectively.

Another concept that can be introduced at this point is the marginal product of labor. By the construction of the game, the marginal product of labor is constant at 180. It can also be pointed out to students the relationship between the constant marginal product of labor and the linearity of the production function. Additionally, a typical production function in reality experiences diminishing marginal product of labor because the amount of capital is

Table 3. Production Function

Labor (hours)	**Metal Production Per Slot**	**Total Metal Production**
0	0	0
1	60	180
2	120	360
3	180	540

Figure 10. Production Function



fixed, which is not captured by this game.

Cost Structure

Once the production function is defined, it is straightforward to introduce the cost structure for the city's metal production. The total fixed cost (TFC), total variable cost (TVC), total cost (TC), average fixed cost (AFC), average variable cost (AVC), and average total cost (ATC) in the short run are shown in Table 4. It is important to note that the average total cost is always strictly decreasing in the quantity of metal produced because of the constant marginal product of labor.

The long-run cost structure can also be discussed in this example. In the long run, since the city can build or demolish industrial buildings, there is no fixed cost. To keep the example

Table 4. Cost Structure (One Basic Factory)

Labor (Hours)	**Number of Metals**	**TFC**	**TVC**	**TC**	**AFC**	**AVC**	**ATC**
0	0	500	0	500	–	–	–
1	180	500	200	700	2.78	1.11	3.89
2	360	500	400	900	1.39	1.11	2.50
3	540	500	600	1100	0.93	1.11	2.04
4	720	500	800	1300	0.69	1.11	1.81
5	900	500	1000	1500	0.56	1.11	1.67
6	1080	500	1200	1700	0.46	1.11	1.57
7	1260	500	1400	1900	0.40	1.11	1.51

simple, the city can only build basic factories. If the city builds another basic factory in the long run, the cost structure is as presented in Table 5.

The students can now see how the long-run average cost curve is traced out through multiple short-run average total cost curves. To produce 180 metals, it is optimal for the city to only have one basic factory because it gives an average total cost of 3.89 Simoleons. Having two factories gives an average total cost of 6.11 Simoleons. However, if the city intends to produce 1,260 metals, having two basic factories is optimal since it gives a lower average total cost of 1.35 as compared to 1.51 with one basic factory. More generally, having two basic factories is optimal if the plan is to produce 900 or more metals. Otherwise, having one basic factory is optimal. The example can definitely be extended to include a cost structure table for more than two basic factories to trace out the entire long-run average cost curve.

For a more challenging exercise, one can explore the possibility of building other types of industrial buildings in the long run. It is entirely possible that basic factories are not the most cost-effective industrial buildings to have in the city for the production of metal.

Attached is Appendix A.2 that provides a classroom activity on firm production and cost structure. A.2.

Table 5. Cost Structure (Two Basic Factory)

Labor (Hours)	Number of Metals	TFC	TVC	TC	AFC	AVC	ATC
0	0	1000	0	1000	–	–	–
0.5	180	1000	100	1100	5.56	0.56	6.11
1	360	1000	200	1200	2.78	0.56	3.33
1.5	540	1000	300	1300	1.85	0.56	2.41
2	720	1000	400	1400	1.39	0.56	1.94
2.5	900	1000	500	1500	1.11	0.56	1.67
3	1080	1000	600	1600	0.93	0.56	1.48
3.5	1260	1000	700	1700	0.79	0.56	1.35
4	1440	1000	800	1800	0.69	0.56	1.25
4.5	1620	1000	900	1900	0.62	0.56	1.17
5	1800	1000	1000	2000	0.56	0.56	1.11
5.5	1980	1000	1100	2100	0.51	0.56	1.06
6	2160	1000	1200	2200	0.46	0.56	1.02
6.5	2340	1000	1300	2300	0.43	0.56	0.98
7	2520	1000	1400	2400	0.40	0.56	0.95

Limitations

It is important to note the limitations of this example to introduce production function and cost structure. First, since there is no labor in SimCity BuildIt, the labor cost that constitutes the variable cost has to come from the time spent by the player producing the items. Thus, the cost of labor is the valuation of the player's own time in terms of the game currency – Simoleons. Another way of introducing labor costs is to let students consider the possibility of hiring someone else to run the productions for them. The amount of Simoleons that they have to pay the person they hire is the cost of labor.

The second limitation is the linear production function. Since the production of every additional item takes the same amount of resources, the marginal product of labor is constant instead of diminishing. It is important to inform students that this is most likely not the case in the real economy. The consequences of a linear production function are a constant marginal cost and a strictly decreasing average total cost curve. Therefore, there is no opportunity to show students how firms can minimize average total cost or maximize profit.

The classroom activity in Appendix A.2 imposes an upper-bound on the labor hours that students can employ. Naturally, they should select the upper-bound to minimize the average total cost of their production. One potential solution to this is to have an increasing cost of labor. For example, the first labor hour costs 200 Simoleons, the second labor hour costs 300 Simoleons, and so on.

5. Logistics

In this section, the logistics of how to incorporate the game into teaching topics in

production is described. Information that is particularly essential is the estimated playing time necessary to unlock the features required in the examples that are presented in Sections 3 and 4 and the classroom activities in the Appendix.

The production possibility example with raw materials that are presented in Section 3.1 only requires students to unlock the production of metal and wood at levels 1 and 2, respectively. It typically takes less than 10 minutes of playing to achieve level 2. The example with the production of items in Section 3.2 requires students to reach level 25, which can take up to two weeks. Using raw materials to introduce production possibilities is significantly more feasible. For the classroom activity in Appendix A.1, students have to unlock plastic and seeds at levels 5 and 7, respectively. It should not take students more than an hour of playing to reach level 7.

The example of production function and cost structure presented in Section 4 does not require any playtime. The production of metal and all the necessary industrial buildings are unlocked at level 1. The classroom activity in Appendix A.2 requires students to unlock seeds, which is at level 7. However, the activity can be easily changed to the production of plastic, which unlocks at level 5, or wood, which unlocks at level 2. The activity also requires students to unlock the Trade Depot at a population of 8,000 to know the prices at which they can sell the items they produce.

SimCity BuildIt is listed on the author's class syllabus as a required component. After going over the syllabus in the first class of the semester, students download and play the game for the remainder of class time. This is a good opportunity to handle any technical difficulties students might have in accessing the game. From past experience, every student can get to at least level 2 to unlock wood production before the first class ends. There are usually a few students in the class who have already played the game, and the instructor can take advantage of that by having them share their experience playing the game.

The first class is the only class time allocated for students to play the game. For the remainder of the semester, students play the game outside of the classroom. A week before introducing a new topic or concept that incorporates the game, students are informed about the features that they need to unlock before attending the class. This becomes part of their "homework" for the week, together with any reading and problem set that they usually have. Once a topic is introduced, students work on a classroom activity in groups. Samples of classroom activities for production possibility and firm production can be found in Appendix A.1 and A.2. Since the amount of time that students have to spend playing the game is quite insignificant, it is rare to have students not have the required features on their game to follow the examples presented in class or to work on their classroom activities.

It is also important to emphasize that to fully participate in class, students do not have to spend more than two or three hours over the semester playing the game. They also do not have to make any in-app purchases.

6. Beyond Production

The application of SimCity BuildIt in economic teaching is not limited to topics in production. It can be used as examples and motivations for many other topics in both microeconomics and macroeconomics. For a first-year seminar course, the author developed a semester-long curriculum to introduce various topics in economics to students using

the game. Production possibility and cost structure are among those topics. The other topics include demand and supply, taxation, externalities, utilities, scarcity, and economic growth. The remainder of this section describes how I use elements in SimCity BuildIt for each of the other topics.

The element in SimCity BuildIt that can best motivate the demand and supply model is the Global Trade HQ which unlocks when the city hits 10,000 in population. It allows players to trade raw materials and items with each other. In the classroom activity for the demand and supply topic, students can sell an item of their choice at different prices to partially trace out the market demand for the item. They can look at the Global Trade HQ for the prices at which other players sell the same item to partially trace out the market supply. At the end of the activity, they have to come up with explanations on why the demand and supply they observe are as such, and also the price that they think is the most appropriate to sell the item at in the future.

Taxes that the city collects from the population and the services provided to the population financed by the tax revenue can be used to introduce public finance. Any development of the city including factories, parks, schools, and fire departments is part of the public spending of the city. Since taxes in the game are lump-sum, it is not appropriate to use them to introduce or motivate taxes on goods and services in the demand and supply model. SimCity BuildIt is also well suited to introduce externalities. Negative externalities using the pollution created by industrial buildings, power plants, sewage facilities, and waste management facilities are introduced. Each building that creates pollution has a well-defined pollution radius to indicate how far the building has to be away from residential buildings to avoid a decrease in the happiness of the population. In the classroom activity on externalities, students record the tax revenue that their city can collect in a day. Then, they have to move a coal power plant that has a pollution radius of 10 by 10 and creates 12 units of power to a highly populated area of their city. The decrease in the amount of tax that the city can collect in a day resulting from this move measures the negative externality from producing 12 units of power, which can then be used to determine how much to shift the supply curve of electricity to get the social cost curve.

There are also examples from SimCity BuildIt that can be used for positive externalities. Parks, landscape, educational buildings, transportation, beach facilities, and other buildings listed under "specializations" can boost the population of the residential buildings around them, hence creating positive externalities.

The happiness of the city can be interpreted as the utility of households among the population. The overall happiness of the city increases when residential buildings are generally close to parks, schools, police stations, fire departments, and hospitals. Sufficient utility services such as power, water, sewage, and waste management also increase the happiness of the city. Pollution that comes from factories, sewage facilities, and power plants can negatively affect happiness if they are placed too close to residential buildings. The happiness of the city can be introduced as a utility function that includes all the variables and factors that affect happiness.

The concept of scarcity appears in many aspects of the game. The production possibility example presented in Section 3 indirectly introduces scarcity since players have a limited amount of time to produce raw materials. Scarcity can also be introduced as a constrained optimization problem faced by the mayor. The mayor has a limited amount of tax revenue and has to allocate it as efficiently as possible to maximize the happiness of the city. This

includes locating public services strategically across the city, deciding on what types of public services are most needed in the city, and making sure power, water, sewage, and waste management are run smoothly in the city.

Since the time commitment to unlocking the elements required to introduce all the topics described in this paper is quite low, instructors can use the game to any extent they see appropriate, even if it is only for one or two topics out of a semester-long course. The game serves as a complementary role to existing introductory courses in economics in that instructors can extract examples from the game to add to the real-world examples that are usually presented to students. It also makes the introduction of these topics more engaging. It is important to acknowledge that the game is not a replacement but a complement to existing pedagogical techniques that have been commonly implemented across introductory economics courses.

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Appendix A

A.1 Sample Classroom Activity on Production Possibility

1. Consider the production of plastics and seeds in SimCity BuildIt. Assume that you have three small factories and two basic factories. You want to know how much plastic and seeds you can produce in 12 hours.

   a. The table below shows the combinations of plastics and seeds that are possible to produce given the resources described above. Fill in the empty columns.

   Students have to first extract the necessary data from SimCity BuildIt. Each small factory has two production slots and each basic factory has three production slots. The total number of production slots is $3 \times 2 + 2 \times 3 = 12$. Also, each plastic takes nine minutes and each seed takes 20 minutes to produce.

   Production point A devotes all 12 hours for the production of seeds. Since each seed takes 20 minutes, the number of seeds that can be produced is

$$\frac{12 \text{ hours} \times 60 \text{ minutes} \times 12 \text{ production slots}}{20 \text{ minutes}} = 432.$$

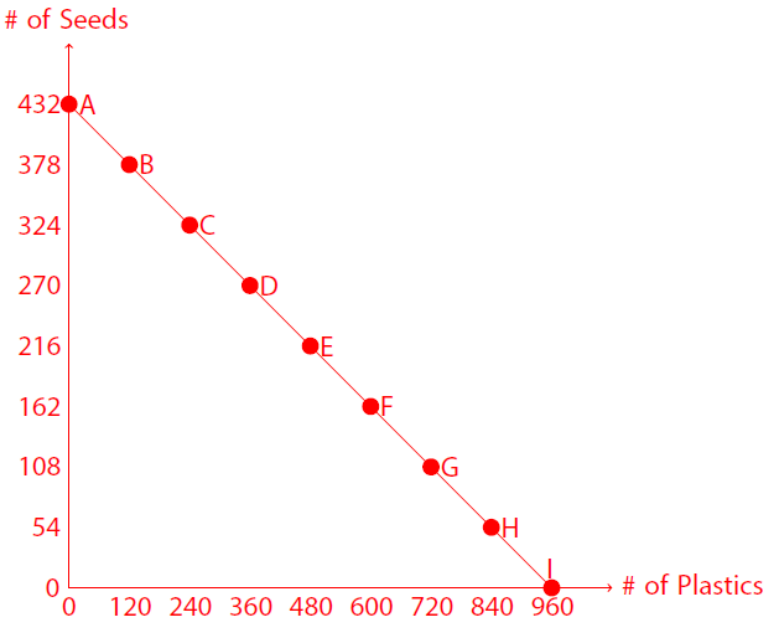
Production point B has to first produce 120 plastics and devote the remaining time for the production of seeds. Therefore, the number of seeds that can be produced is

$$\frac{12 \text{ hours} \times 60 \text{ minutes} \times 12 \text{ production slots} - 120 \text{ plastics} \times 9 \text{ minutes}}{20 \text{ minutes}} = 378.$$

The number of seeds in the remaining production points can be calculated similarly.

Points	Number of Plastics	Number of Seeds
A	0	432
B	120	378
C	240	324
D	360	270
E	480	216
F	600	162
G	720	108
H	840	54
I	960	0

b. In the space below, plot the above points to obtain the production possibility frontier.



c. What is the slope of your production possibility frontier?

$$-\frac{432}{960} = -0.45$$

d. What is the opportunity cost of producing one plastic (in terms of number ofseeds)?
0.45 seeds

e. What is the opportunity cost of producing one seed (in terms of the number of plastics)?
2.22 plastics

f. For each of the following production combinations, first determine whether it is possible. If it is possible, determine if it is efficient in production,

1. 0 plastic and 430 seeds.

$$\frac{0 \text{ plastic} \times 9 \text{ minutes} + 430 \text{ seeds} \times 20 \text{ minutes}}{12 \text{ production slots} \times 60 \text{ minutes}} = 11.94 \text{ hours} < 12 \text{ hours}$$

Possible but inefficient.

2. 840 plastics and 55 seeds.

$$\frac{840 \text{ plastic} \times 9 \text{ minutes} + 55 \text{ seeds} \times 20 \text{ minutes}}{12 \text{ production slots} \times 60 \text{ minutes}} = 12.03 \text{ hours} > 12 \text{ hours}$$

Not possible.

3. 600 plastics and 162 seeds.

$$\frac{600 \text{ plastic} \times 9 \text{ minutes} + 162 \text{ seeds} \times 20 \text{ minutes}}{12 \text{ production slots} \times 60 \text{ minutes}} = 12 \text{ hours}$$

Possible and efficient.

4. 500 plastics and 207 seeds.

$$\frac{500 \text{ plastic} \times 9 \text{ minutes} + 207 \text{ seeds} \times 20 \text{ minutes}}{12 \text{ production slots} \times 60 \text{ minutes}} = 12 \text{ hours}$$

Possible and efficient.

5. 345 plastics and 280 seeds.

$$\frac{345 \text{ plastic} \times 9 \text{ minutes} + 280 \text{ seeds} \times 20 \text{ minutes}}{12 \text{ production slots} \times 60 \text{ minutes}} = 12.09 \text{ hours} > 12 \text{ hours}$$

Not possible.

6. 222 plastics and 330 seeds.

$$\frac{222 \text{ plastic} \times 9 \text{ minutes} + 330 \text{ seeds} \times 20 \text{ minutes}}{12 \text{ production slots} \times 60 \text{ minutes}} = 11.94 \text{ hours} < 12 \text{ hours}$$

Possible but inefficient.

2. Consider the same production as in Question 1 but you only have two small factories and no basic factories. Everything else remains the same as in Question 1.

a. What is the opportunity cost of producing one plastic (in terms of number of seeds)?
0.45 seeds

b. What is the opportunity cost of producing one seed (in terms of the number of plastics)?
2.22 plastics

c. Without drawing the production possibility frontier, give a production combination that satisfies each of the following descriptions.

1. Impossible to produce.
Any combinations that require strictly more than 2,880 minutes of production time. Examples: 300 plastics and 400 seeds, 1 million plastics and 2 millions seeds, 0 plastics and 5000 seeds.

2. Possible but inefficient.
Any combinations that require strictly less than 2,880 minutes of production time. Examples: 0 plastic and 0 seeds, 1 plastic and 2 seeds, 200 plastics and 50 seeds.

3. Possible and efficient.
Any combinations that require exactly 2,880 minutes of production time. Examples: 0 plastic and 144 seeds, 320 plastic and 0 seeds, 160 plastics and 72 seeds.

A.2 Sample Classroom Activity on Firm Production and Cost Structure

1. You are the mayor of a Sim City with two basic factories. In the short run, you are not allowed to build or demolish factories. You value your own time as a mayor at 250 Simoleons per hour (labor). Assume that the only fixed costs are the costs of the factories, the only variable cost is the value of your time (labor), and that you are only interested in producing seeds.

a. The table below shows your production schedule. Fill in the empty columns.
Students first have to extract from the game that each basic factory has three production slots and costs 500 Simoleons. There are six production slots from the two basic factories. It can also be taken from the game that each seed takes 20 minutes to produce. Each hour, the mayor is able to produce

$$\frac{1 \text{ hour} \times 60 \text{ minutes}}{20 \text{ minutes}} \times 6 = 18 \text{ seeds.}$$

The total fixed cost (TFC) is $2 \times 500 = 1{,}000$ Simoleons.

Labor (hours)	Number of Seeds	TFC	TVC	TC	AFC	AVC	ATC	MC
0	0	1,000	0	1,000	–	–	–	–
1	18	1,000	250	1,250	55.56	13.89	69.44	13.89
2	36	1,000	500	1,500	27.78	13.89	41.67	13.89
3	54	1,000	750	1,750	18.52	13.89	32.41	13.89
4	72	1,000	1,000	2,000	13.89	13.89	27.78	13.89
5	90	1,000	1,250	2,250	11.11	13.89	25.00	13.89

b. In the space below, plot the production function for seeds. Remember to put labor hours on the horizontal axis and the number of seeds you can produce on the vertical axis.

c. What is the slope of your production function?
18.

d. What is the marginal product of labor? Give a brief interpretation of the value you get.
18. Each additional hour of labor produces 18 additional seeds.

e. If all you care about is achieving the lowest cost per seed, how many labor hours should you employ? Assume that you only get to choose between 0 and 5.
5

f. If you were to sell seeds on the trading post, what is the maximum number of coins you can receive for each seed?
110 Simoleons. (This number has to be obtained from the game)

g. Assuming that you employ the number of labor hours from (e), if you sell all the seeds you produce at the trading post at the maximum price, how much revenue will you receive in total?
90 x 110 = 9,900 Simoleons

h. How much is your profit?
9,900 – 2,250 = 7,650 Simoleons

2. Consider the long run. You are now able to build new factories or close down existing ones. Assume that you can only build basic factories.

a. How many basic factories do you want to have? You can pick any number other than two.
(Students can potentially pick any number other than two. The answers to the remaining questions will depend on the number chosen.)

b. Based on the number of basic factories that you chose above, fill in the following table.

Labor (hours)	Number of Seeds	TFC	TVC	TC	AFC	AVC	ATC	MC
0	0	1,500	0	1,500	–	–	–	–
1	27	1,500	250	1,750	55.56	9.26	64.81	9.26
2	54	1,500	500	2,000	27.78	9.26	37.04	9.26
3	81	1,500	750	2,250	18.52	9.26	27.78	9.26
4	108	1,500	1,000	2,500	13.89	9.26	23.15	9.26
5	135	1,500	1,250	2,750	11.11	9.26	20.37	9.26

c. How many labor hours should you employ to achieve the lowest average total cost? Again, assume that you can only pick from 0 to 5 hours.
5

d. Assuming that you sell all your seed production at the maximum price at the trading post, what is the profit you receive for employing the number of labor hours you got from (c)?
135 x 110 – 2,750 = 12,100 Simoleons