Chapter 1

Introduction

Economics analyzes how individuals, households, firms, governments, and society in general employ scarce resources to produce goods and services. Economists are concerned with the efficient allocation of resources such that no other allocation would make society better off. They use mathematical, theory-based models to represent the aforementioned actors and how they interact in a market or engage in economic activity. Only relevant features are included in models and not every detail. That is, a model is not made more complicated than necessary to determine the outcomes of interest. Empirical work is done to test economic theories with statistics being a common tool for economists. Yet, knowing how to run statistical tests does not by itself make one an economist. Economic analysis requires a theoretical framework that links data to questions about behavior and policy. For example, in financial economics, understanding portfolio choice or asset pricing involves concepts such as risk aversion, arbitrage, and market efficiency in addition to regression analysis. In macroeconomics, analyzing savings, investment, or consumption over time requires tools from dynamic optimization, such as intertemporal choice models and the use of discounting. Statistics is essential, but it is only one part of a broader toolkit that combines theory, modeling, and empirical evidence. Although this book limits the use of mathematics, the reader should keep in mind that there is a mathematical relationship behind every graph presented.

It is important to recognize that economics, as it is commonly taught, presented, and used, has limitations. University curricula have often focused narrowly on neoclassical models of rational, self-interested individuals, leaving students with a restricted view of how economies function. Such approaches can overlook pressing contemporary challenges, including financial instability and environmental pollution. Yet, while economics has shortcomings when applied too rigidly—or worse, by ignoring tools that it has to offer—it remains one of the most powerful and important tools for policy analysis. For example, economics does

not ignore issues such as environmental degradation but treats it as a so-called externality, meaning costs or benefits that spill over onto others and are not reflected in market prices. Addressing externalities does not necessarily contradict profit-maximizing behavior, since firms can still pursue efficiency within a framework that accounts for these costs. When policymakers take externalities into account—through regulation, (so-called Pigouvian) taxes, or incentives—they can correct market failures and thereby increase overall economic efficiency.

The discipline provides a framework for weighing trade-offs, for anticipating the likely effects of government interventions, and for designing policies that can improve societal welfare under real-world constraints. A broader and more pluralist use of economics—one that acknowledges the complexity of human behavior—makes the discipline not only more realistic but also more relevant for guiding public policy.

Microeconomics and macroeconomics are the two large branches of economics with the former being the main subject of this book. Microeconomics analyzes the behavior of individuals and firms whereas macroeconomics assesses the behavior of the economy as a whole. Economic concepts are (explicitly or implicitly) used by individuals, firms, and governments on a continuous basis. An economist would say that most everyday life decisions are based on economic principles starting with the decision to get out of bed in the morning.[1] The American Economic Association (AEA) has compiled a list of real-world economics covered in their scientific journals. Here is a selection of the topics covered:

- **Microeconomic behavior and market outcomes**: Economists study individual decision-making and how it shapes markets. Research on health insurance markets highlights problems of adverse selection and moral hazard, demonstrating why private provision of healthcare may fail to achieve efficiency. The study of altruism and charitable giving goes beyond narrow self-interest to explore the role of social preferences and norms. Similarly, behavioral economics examines how individuals deviate from rational choice assumptions—for instance, why they ignore information or respond inconsistently to incentives—and what this implies for market outcomes and policy design.
- **Industrial organization and institutions**: A major area of research focuses on the structure of markets and the role of firms. Economists analyze cartels, market concentration, and monopoly power, assessing how collusion, consolidation, mergers, or oligopoly structures affect prices, in-

[1] From an economic perspective, people get out of bed in the morning because the marginal benefit of staying under the covers eventually falls below the marginal cost. At first, the utility of warmth, comfort, and a few extra minutes of sleep is high, but as time passes, the opportunity costs start to mount, i.e., missed wages, cold coffee, or the risk of losing one's job altogether. Even the most die-hard sleeper recognizes that the expected utility of engaging in daily activities—earning income, consuming goods, or even just having breakfast—eventually outweighs the benefits of the snooze button.

novation, and consumer welfare. Contract theory extends this logic to agreements among individuals, firms, or even sovereign states, asking how contracts can be designed to overcome problems of enforcement and trust. These insights are central to competition policy, financial regulation, and the design of institutions that shape economic activity.

- **Macroeconomic stability and crises**: At a broader scale, economists investigate the sources of instability in national and global economies. The study of financial crises explores how bank failures, systemic risk, and the interconnectedness of financial institutions can amplify shocks. Economists also evaluate the role of central banks, particularly the Federal Reserve, in stabilizing inflation, mitigating recessions, and preventing crises from spreading across sectors or countries. Historical research on episodes such as the Great Depression, the 2008 financial crisis, and recent banking failures provides crucial lessons for current policy debates.
- **Global challenges and development**: Economics also provides insights into pressing issues that cross national borders. Work on climate change and pollution frames these as externalities, emphasizing the role of taxes, subsidies, and regulation in aligning private incentives with social costs. Studies of international trade examine how comparative advantage, globalization, and protectionist policies affect growth, urbanization, and inequality. Development economics investigates phenomena such as the resource curse, asking why some resource-rich countries struggle to translate wealth into sustainable development, while others succeed.
- **Labor, inequality, and social dimensions**: On a more individual level, economists devote significant attention to human capital, incentives, and risk aversion. These topics address why individuals invest in education, how households respond to taxes and subsidies, and why many avoid investments in risky but potentially high-return assets (which is called the equity premium puzzle). The study of unemployment, labor market dynamics, and inequality connects microeconomic choices to broader societal outcomes, showing how shifts in technology, trade, or policy affect income distribution and employment opportunities. More recently, economists have expanded their focus to social capital and culture, acknowledging that norms, institutions, and collective behavior shape economic outcomes in ways that extend beyond markets.

Taken together, these diverse topics show that economics is not confined to abstract models but serves as a versatile toolkit for analyzing real-world problems. Whether the focus is on inequality, technological disruption, taxation, unemployment, or the design of effective policy interventions, economics provides a set of analytical frameworks for assessing trade-offs, predicting consequences, and evaluating welfare. This breadth underscores its importance for public policy, where rigorous analysis across microeconomic, macroeconomic, and global domains is essential for designing policies that improve both efficiency and equity in society. The chapters in this book show how even neo-classical economics—

which has come under criticism over the years—with its assumption of rational choice provides a plethora of tools to address many public policy issues.

This book deviates from a traditional microeconomics book by focusing heavily on aspects that are of interest to public managers. Specifically, policies as they relate to market failures and inefficiencies are covered in detail since those policies are often implemented at the local or state-level. Although important macroeconomic topics such as unemployment, interest rates, trade, national income, inflation, and many more are of great importance to every country, those issues go beyond the scope of a single public manager and thus, are not covered. This book can be broadly categorized into the following topics:

- **Consumer theory**: Consumer theory uses the concept of utility maximization to derive the demand curve. Consumer theory is important in terms of welfare economics, e.g., assessing the welfare effects for consumers after a change in policy, prices, or income. Topics covered in this section include income and substitution effects as well as compensating and equivalent variation. These concepts allow economists to separate how consumers adjust their choices when relative prices change from how they respond to changes in purchasing power. They also provide tools to measure how much compensation would be required to make consumers as well off after a policy change as they were before, thereby linking individual behavior to broader welfare analysis.
- **Producer and cost theory**: Whereas the goal of consumer theory is to derive the demand function, producer theory derives the supply function for a good. Producer theory is less abstract than consumer theory because concepts such as profit maximization and cost minimization are easier to understand. A key concept introduced in this section is marginal cost, i.e., the additional cost of producing one more unit. Marginal cost has important implications beyond producer theory. Cost theory, which includes concepts such as fixed, variable, average, and marginal costs, provides the foundation for understanding how firms make production decisions. Cost functions summarize these relationships and allow us to connect inputs, technology, and output to the supply curve. Producer welfare, often measured as producer surplus, captures the benefits that firms receive from selling goods at a market price above their marginal cost of production. This mirrors consumer welfare, which is measured by consumer surplus, and together the two concepts form the basis for analyzing total welfare in society. By considering both consumer and producer surplus, economists can evaluate how policies or market changes affect not just one group but overall economic efficiency and societal welfare.
- **Demand and supply**: The combination of demand and supply derived from consumer and producer theory, respectively, determines the quantity and price that lead to a market equilibrium, i.e., a situation with neither excess demand nor excess supply. It is important to differentiate between a change in quantity demanded (supplied) versus a change in demand (supply). The concept of elasticity is introduced in this context as well.

- **Market Structures**: Once demand and supply are developed, we introduce perfect and imperfect competition, which are two broad types of market structures. Perfect competition is characterized by price-taking behavior of consumers and producers. That is, the market actors have no control over the price at an individual level. Price setting behavior in the case of imperfect competition occurs because consumers and/or producers have certain control over the market price. A market with only one producer for a good is called a monopoly whereas an oligopoly has a small number of producers. Perfectly competitive or monopolistic markets are relatively easy to analyze since in the former, firms have no control over the market price whereas in the latter, the producer has full control over the market price. Oligopolies are more difficult to assess since producers have partial but not full control over the price.
- **Game theory**: Some of the models used to assess oligopolies are quite old and game theory has introduced strategic interaction among economic agents as a new way of thinking about those markets. Each game has three components: (1) players, (2) actions, and (3) payoffs. Game theory is not only used in economics but has a wide range of applications in the fields of biology, political science, conflict resolution, and many more.
- **Market failures and public policy**: The benchmark to which we compare economic outcomes is the perfectly competitive market, which maximizes social welfare. Market failures do not achieve the efficient outcome. Besides imperfect competition, there are other instances where markets fail to achieve the efficient outcome such as in the presence of externalities, public goods, or asymmetric information. Most economic analysis requires the existence of a market but for some goods (e.g., clean air, clean water) no market exists. Non-market valuation in the field of environmental economics attempts to attach value to goods for which no market exists. Market failures provide the central rationale for public policy, since government intervention—through regulation, taxation, subsidies, or direct provision of goods—can correct inefficiencies and move society closer to the social optimum. Understanding the specific type of failure is therefore essential for designing effective policies, as the tools to address pollution differ from those that tackle monopoly power or information asymmetries.
- **Risk and uncertainty**: Almost all economic activities involve some uncertainty. Decisions that are made today affect the outcome tomorrow which is usually uncertain. In this part, we assess how consumers and producers incorporate uncertainty.
- **Dynamic aspects**: With the exception of repeated and sequential games in the section on game theory, there is no time component in the presentation of the previous topics. In reality, almost all economic decisions have a time factor associated with them similar to risk and uncertainty. Aspects such as net present value, optimal resource management, and intertemporal decision making are introduced as well as policies to manage the implications of including dynamic aspects into economic analysis.

There are many economic concepts that are useful in everyday life. Those concepts are analyzed in detail in the subsequent chapters. Some of the most important concepts are marginal analysis, sunk cost, and opportunity cost.

- **Marginal analysis**: Economists focus on the margin, i.e., what is the benefit of the next good that is bought or sold, which leads to the concept of marginal analysis. Once you have purchased something, what matters is what you will do next. Can you make yourself better off? Our goal is to maximize net benefit: the value of the good minus its cost. Hence, the additional (marginal) benefit must be greater than or equal the additional (marginal) cost. Examples are choosing the production quantity or renting a car, which is based on the additional cost associated with more amenities and comfort. For the maximization of total benefit, we focus on marginal benefit and marginal cost. If the marginal benefit is larger than the marginal cost, total benefit will increase. If the marginal cost is larger than the marginal benefit, total benefit will decrease. The only time that total benefit will not rise or fall is when marginal benefit is equal to marginal cost. This is where total net benefit is maximized.
- **Sunk cost**: A concept closely related to marginal analysis is sunk cost. Sunk costs are expenditures that have been made and cannot be recovered. Following from marginal analysis, sunk costs should be ignored. Since sunk costs cannot be changed, they have no influence on decision-making. This concept is controversial because it does not always hold in reality. For example, students who consider abandoning their degree should not take the time spent into account while making their decision since time is considered sunk cost.
- **Opportunity cost**: Another example of costs that are considered by economists are opportunity costs which are the value of the next best alternative use of a resource, i.e., cost of forgone opportunities. For students, the cost of going to university is tuition plus the opportunity cost, i.e., salary forgone from not working. Opportunity costs are important to consider, but often ignored. Opportunity costs relate to the key concept of scarcity. Once a resource has been used, it cannot be used for something else. For example, opportunity cost lead to significant wage differentials in a university setting between business and law school faculty and other professors. Faculty in business and law school can have significant earnings in industry. Universities must overcome those high opportunity costs in order to retain them.

Economics should be thought of in very broad terms and not just money and/or profit. Consider the example of saving human lives in the context of transport planning. In many regions in the U.S. and the world, people have a choice when it comes to transport modes, e.g., car, bike, train. Depending on the price of those modes, consumers substitute one for the other. However, there are also different fatality rates associated with each transport mode with cars probably having one of the highest. Thus, if you increase train ticket prices to finance safety investments, some people shift from the train to the road potentially

causing more fatalities despite the investment in safety. Just focusing on road safety, an increase in the price of gasoline reduces road fatalities (Burke and Nishitateno 2014).

1.1 Nominal versus Real Prices

Before starting with consumer theory, let us first introduce the difference between nominal and real prices based on index numbers and indices. An index number assigns a single value to several individual numbers. For example, a single value of the Dow Jones Industrial Average (DJIA) represents an index number summarizing the market value of the companies composing the DJIA. An index number can be a simple average or a weighted number. In the case of the DJIA, the index number is weighted by stock price. An index is a series of index numbers used to track a variable's rise and fall over time. The DJIA or S&P 500 are important indices tracking the performance of the U.S. stock market.

In economics, price indices are key to convert nominal to real prices. In general, only real prices are important. Let us illustrate this point with an example. Suppose that your income in period 1 is \$100. The price of apples and milk is \$5 and \$10, respectively. You purchase 4 apples and 8 gallons of milk. You can easily verify that this allocation exhausts your income. In period 2, your income is \$120 and the price of apples and milk increased to \$6 and \$12, respectively. Although your (nominal) income has increased from \$100 to \$120, you can only purchase the same quantities of apples and milk in both periods. Your nominal income increased from \$100 to \$120 but since you cannot purchase more goods, your real income has not changed. If your income had increased to \$110 in the second period, then your nominal income would have increased whereas your real income would have decreased.

1.1.1 Price Indices

There are four main price indices to convert nominal to real prices. Their use depends on the type of prices that are converted. For consumer prices, the two relevant indices are the Consumer Price Index (CPI) (Panel (a), Figure 1.1) or the Personal Consumption Expenditure (PCE) Price Index. To convert prices for producers, the Producer Price Index (PPI) is used (Panel (b), Figure 1.1). The most general index is the gross domestic product (GDP) deflator.

The Consumer Price Index (CPI) is published by the Bureau of Labor Statistics (BLS) every month and is a *"measure of the average change over time in the prices paid by urban consumers for a market basket of consumer goods and services."* Note that urban consumers are very broadly defined representing over 90% of the U.S. population. The market basket consists of approximately 80,000 items with weights assigned based on typical expenditure shares to food and beverages (15%), housing (43%), apparel (4%), transportation (17%), medical

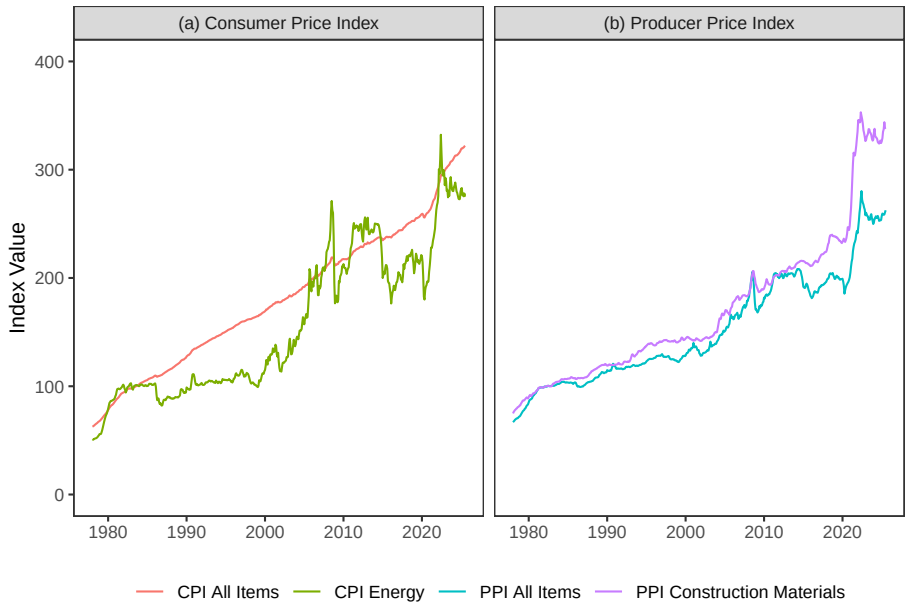

Figure 1.1: Panel (a): CPI for all items and energy (U.S. city average). Panel (b): PPI for all commodities and construction materials. Source: Federal Reserve Economic Data from the St. Louis Fred.

care (6%), recreation (6%), education and communication (6%), and other goods and services (3%). The CPI is set to 100 over the average of 1982–1984. We can use the following equation to calculate the CPI:

$$CPI_t = \frac{MB_t}{MB_b} \cdot 100$$

where MB_t and MB_b represent the cost of the market basket in time period t and the base year b (i.e., average over the years 1982–1984), respectively. Since the CPI is an index, the base year can be adjusted for specific purposes.

The CPI is used as an economic indicator to set policy targets or to adjust dollar values over time such as pensions. There are many different decompositions of the CPI by type of good and geographic location. Panel (a) of Figure 1.1 shows the CPI for all items and energy. As can be seen in the figure, there are much stronger fluctuations for energy than for all items in the market basket. This strong fluctuation of energy items becomes important in the later section when "headline" is differentiated from "core" inflation.

The CPI uses a fixed market basket and hence, suffers from substitution bias which refers to the situation where consumers shift away from goods whose relative prices increase. The second problem is associated with new, higher

priced goods being introduced to the market. That is, the CPI fails to take quality improvements into account that are responsible for the increase in prices. Of course, there are also items that fall out of the market basket over time due to their obsolescence. As opposed to the CPI, the PCE Price Index is calculated by the Bureau of Economic Analysis (BEA). The index is released each month and reflects changes in the prices of goods and services purchased by consumers in the United States. The differences between the CPI and the PCE are of technical nature with the most substantial distinction being that the PCE allows for substitution of goods. The White House Council of Economic Advisers included the following example in "Crosswalk Talk: What's the difference between the PCE and the CPI?" (29 September 2023):

> *For example, both CPI and PCE measure the price of airfare, but CPI calculates it using a fixed basket of air routes, while PCE calculates it using data on airline passenger revenues and passenger miles traveled.*

In a footnote of the Monetary Policy Report to the Congress (17 February 2000), the Federal Reserve Board states the following:

> *The chain-type price index for PCE draws extensively on data from the consumer price index but, while not entirely free of measurement problems, has several advantages relative to the CPI. The PCE chain-type index is constructed from a formula that reflects the changing composition of spending and thereby avoids [...] fixed-weight nature of the CPI. In addition, the weights are based on a more comprehensive measure of expenditures. Finally, historical data used in the PCE price index can be revised to account for newly available information and for improvements in measurement techniques, including those that affect source data from the CPI; the result is a more consistent series over time.*

The Producer Price Index is similar to the CPI but tracks prices paid by producers. The BLS states that the *"(PPI) program measures the average change over time in the selling prices received by domestic producers for their output."* For example, the electricity price paid by a large industrial firm is different, and behaves differently, than the electricity price charged to consumers.

The GDP deflator includes goods and services purchased by businesses, governments, and foreigners. In addition, it also track price changes of imported goods. The GDP deflator tracks price changes in the economy as a whole and is much broader than the CPI, PCE Index, and PPI.

1.1.2 Constant Dollar Calculations

Prices should be used—and especially displayed—after the conversion into real terms. Many people compare 1970 gasoline prices to today and complain about the price increase without realizing that they are comparing nominal prices.

This would be similar to complaining about the cost increase of a Rolls-Royce. In 1921, a Rolls-Royce Silver Ghost cost $12,000 which at the time was equivalent to the price of three vehicles produced by Cadillac.

In what follows, we calculate the conversion of nominal to real prices using the CPI but the calculations are identical for all other price indices. The first step in the constant dollar calculations is the choice of the base year. As mentioned above, the base b year for the CPI is the average of the period 1982–1984 but a different year can be chosen without issue. Then the following equation converts a nominal dollar amount from period t to b dollars as follows:

$$CD_b = \frac{ND_t \cdot CPI_b}{CPI_t}$$

where CD_b represents the constant dollar or real value in the base year, ND_t is the nominal value in period t, and CPI_b and CPI_t are the CPI values in b and t, respectively. For example, the nominal gasoline price in May 1979 was $0.84 and we want to convert this value to July 2025 $. Then we have $ND_{1979} = 0.84$ (May 1979), $CPI_{1979} = 71.5$, and $CPI_{2025} = 323.048$ with $b = 2025$ and $t = 1979$. Plugging those values into the equation for the constant dollar calculation and we get:

$$CD_{2025} = \frac{ND_{1979} \cdot CPI_{2025}}{CPI_{1979}} = \frac{0.84 \cdot 323.048}{71.5} = 3.80$$

According to the U.S. Energy Information Administration (EIA), the July 2025 gasoline price was $3.12 meaning that gasoline prices in July 2025 were 21.6% higher than in May 1979. Showing nominal dollar values in a plot can be misleading. For example, Figure 1.2 shows the nominal and real price of gasoline over time. We can see that in January 1976, the nominal price of gasoline was $0.61 but the real price was $3.50. A second example uses Wisconsin motor fuel tax revenue (Figure 1.3). The nominal value shows a steady increase over time—which is misleading—since the real motor fuel tax revenue has been declining since around the year 2000. Fuel taxes have not been adjusted in some states and the federal level for a long time period leading to declining revenues for infrastructure projects (Dumortier, Kent, and Payton 2016; Dumortier, Zhang, and Marron 2017).

The difference between nominal and real prices grows considerable time. To illustrate this case, let us consider a second example using the $12,000 Rolls-Royce Silver Ghost. Consider the CPI values for January 1921 and July 2019 as the two time points of interest.

$$CD_{2025} = \frac{ND_{1921} \cdot CPI_{2025}}{CPI_{1921}} = \frac{12,000 \cdot 323.048}{19.0} = \$204,030.30$$

In the case of fuel prices, one may also consider the improvements in fuel efficiency over time. Theoretically, people should care about the cost per mile and not necessarily the price of gasoline. Of course, for the same distance traveled

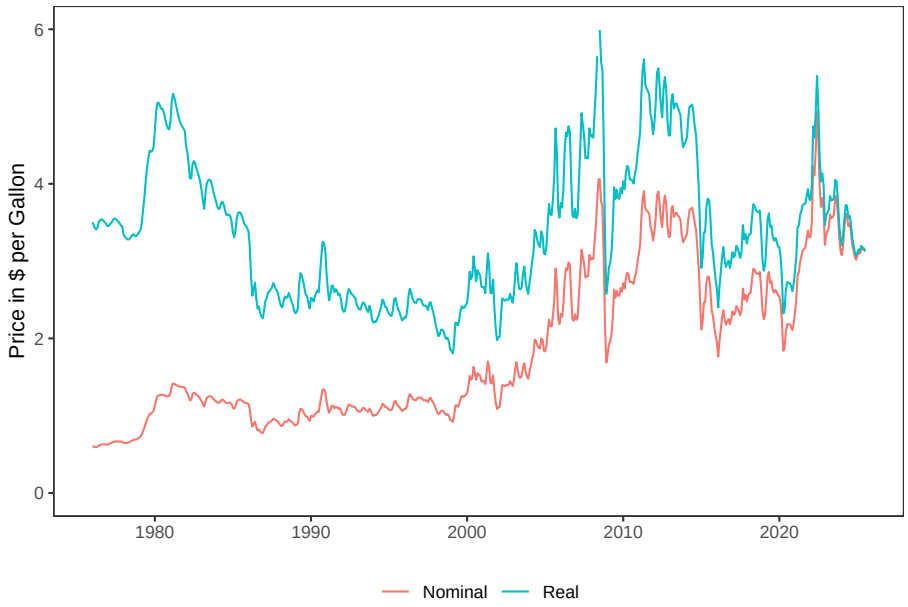

Figure 1.2: Monthly real and nominal regular grade retail gasoline prices from January 1976 to July 2025. Source: EIA Short-Term Energy Outlook, August 2025.

and the same fuel efficiency, both measures are connected. However, give that fuel efficiency has changed over time, driving became much more cheaper in terms of cost per mile (Figure 1.4) EPA (2024).

1.1.3 Inflation

Indices like the CPI and PCE are used by policymakers to make long-term decisions having important implications for the economy. Those decisions are not directly based on the value of the CPI or PCE but the change of those indices over time, which leads to the concept of inflation. In the aftermath of the COVID-19 pandemic, the topic has taken center stage for policymakers around the world. The inflation rate can be calculated as follows:

$$\pi_t = \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \cdot 100$$

There are two important nuances associated with inflation measures. First, inflation is calculated over the previous 12 months. That is, the inflation for July 2025 uses the CPI of July 2024 and July 2025. If prices increase at a rate deemed too high, the Federal Reserve may adjust interest rates. Since those decisions affect home buyers and everyone else making a purchase using a loan,

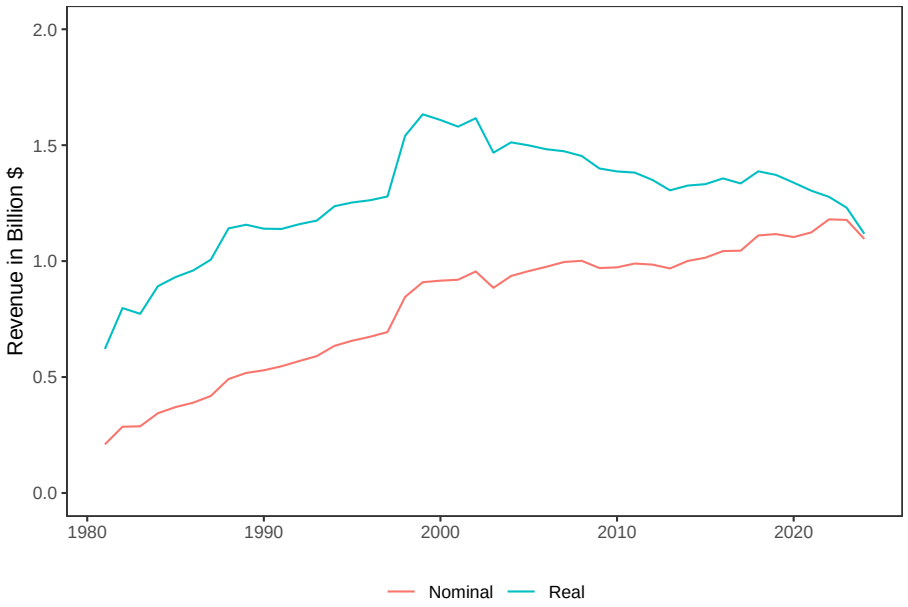

Figure 1.3: Real and nominal motor fuel tax revenue for Wisconsin deflated by the GDP deflator. Source: Federal Reserve Economic Data from the St. Louis Fred.

those decisions have to be based on appropriate data, which leads to the second important aspect, i.e., headline vs. core inflation.

As seen in Panel (a) of Figure 1.1, energy prices are very volatile and extremes in either direction can be short-lived. The same is true for food prices. Thus, prices of food and energy are often taken out of the inflation calculations because it can result in an inaccurate reflection of the (long-term) price level. If all components of the CPI are included in the inflation calculation, the term headline inflation is used. If the calculations are based on the CPI without energy and food, the term core inflation is used. Figure 1.5 shows the annual inflation rate in the U.S. from 1960 to 2020 using the PCE with and without food and energy.

Headline inflation measures the overall change in prices faced by consumers, including all goods and services such as food and energy. Core inflation, by contrast, excludes food and energy prices on the grounds that they are more volatile and can create short-term swings that obscure underlying trends in inflation. While this makes core inflation a useful measure for central banks in setting long-term monetary policy, it can be misleading from a public policy perspective. Food and energy are essential items that households cannot easily substitute away from, and their price increases often hit low- and middle-income families hardest. Excluding them risks downplaying the very costs that most

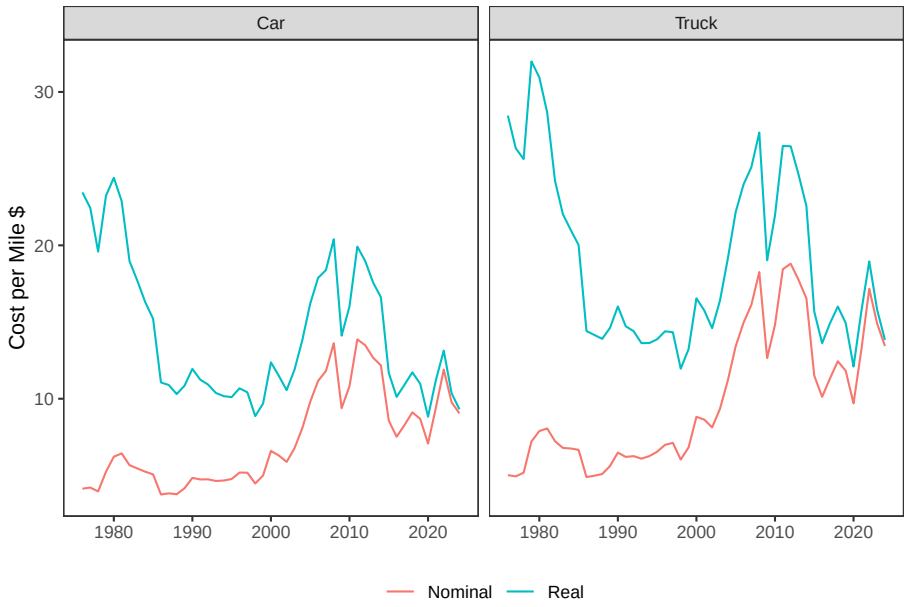

Figure 1.4: Real and nominal cost per mile driven from 1976 to 2025 based on data from the EIA and @EPA:2024.

directly affect people's welfare and that are of central concern to voters and policymakers alike. In that sense, the distinction highlights the tension between the technocratic goal of identifying stable inflationary trends and the lived reality of economic hardship when basic necessities become more expensive.

1.2 Efficiency

An important benchmark in economics is Pareto efficiency. An allocation of resources is Pareto efficient if no one can be made better off without making someone else worse off. This is a very strict standard, since in practice most policy changes create winners and losers. For example, building a new highway may benefit commuters by reducing travel times but displace households living along its route. Because true Pareto improvements are rare, the concept is more useful as an ideal benchmark of efficiency than as a practical policy test.

To address this limitation, economists often use Kaldor–Hicks efficiency. An outcome is Kaldor–Hicks efficient if the winners from a policy change gain enough that they could, in principle, compensate the losers and still be better off, even if no compensation actually occurs. This makes it a looser but more practical criterion for evaluating policies. Returning to the highway example, if the overall benefits in reduced travel costs exceed the losses to displaced households, the

Figure 1.5: Inflation as the growth rate over the last year of the PCE (including all expenditures) and the PCE excluding food and energy. Source: Federal Reserve Economic Data.

project would be Kaldor–Hicks efficient, regardless of whether compensation is paid.

While Pareto efficiency provides a clear but rigid definition of welfare maximization, Kaldor–Hicks efficiency recognizes the trade-offs inherent in real-world policymaking. However, relying on Kaldor–Hicks can be controversial, since it may justify policies that increase total welfare while leaving certain groups worse off. For this reason, economists and policymakers must be careful to balance efficiency considerations with questions of equity and distribution.

1.3 Exercises

The Federal Reserve Bank of St. Louis maintains the Federal Reserve Economic Data (FRED) database (https://fred.stlouisfed.org/) which contains thousands of economic time series. Some of the exercises below make use of the FRED database. Each time series has an ID, which can be used to easily access the data. For example, the GDP deflator has the ID `GDPDEF`.

1. ***Real Energy Price*** (***): The relevant data for this exercise is available in the FRED database. You will calculate the real price of energy over time using the Consumer Price Index (`CPIAUCSL`), the Personal Consumption

Expenditure Price Index (`PCEPI`), and the GDP deflator (`GDPDEF`). The base period is the most recent month for which the indices are available. Pick one of the following energy series: Natural gas (`MHHNGSP`), gasoline (`GASREGW`), or electricity (`APU000072610`). Use the maximum available time period for the data series. For the chosen energy price, use a spreadsheet (e.g., Microsoft Excel) to calculate the real dollar values and graph the results. Your graph should contain four time series for the energy prices, i.e., nominal value and the three real values using the three price indices. What do you observe? Did the energy item of your choice increase, decrease, or remain constant over time? What different conclusions would you draw from using either nominal or real values.

2. ***Annual State Government Tax Collections*** (***): For this exercise, you will convert state-level tax revenue data from nominal to real values. In a first step, go to Annual State Government Tax Collections (https://fred.stlouisfed.org/release/tables?rid=143&eid=151912) and choose one of the following states: Illinois, Kentucky, Ohio, or Michigan. Next, pick one of the following revenue categories: (1) General Sales and Gross Receipts Taxes, (2) Motor Fuels Sales Tax, (3) Individual Income Taxes, or (4) Corporation Net Income Taxes. Download the time series—which is in nominal values over multiple years—to an Excel file. Next, download the annual data for the GDP Deflator (`GDPDEF`). Make sure to use the orange button "EDIT GRAPH" to get the annual data. Once you have the two data series, calculate the real tax revenue for the revenue category and state chosen. The base year is the most current year. In your answer, include an Excel graph showing the evolution of the tax revenue in real and nominal terms over time. Did the tax revenue increase or decrease in nominal terms? Did the tax revenue increase or decrease in real terms?

3. ***CPI Components*** (**): Since the market basket of the CPI contains over 80,000 items, a more detailed analysis is possible for various consumer groups. For this exercise, you will compare the price evolution for four categories: (1) CPI All Items, (2) College Tuition and Fees, (3) Medical Care, and (4) a category of your choice. The data is available at https://www.bls.gov/cpi/data.htm. Download the data for the four categories and graph them in a time series. What do you observe?

4. ***Streetlight Installation*** (**): Three neighbors vote on installing a streetlight. If they vote in favor of the streetlight, each neighbor has to pay $100. They each value the streetlight at $200, $150, and $50, respectively. Does this project meet the criteria of Pareto efficiency? Kaldor-Hicks efficiency? Would it pass a majority vote?

5. Housing Prices and Affordability (***): In this exercise, you are tasked to show the evolution of median income and home values in a state of your choice (except Indiana). To do so, you use the Zillow Home Value Index (ZHVI) for a state of your choice from FRED. For example, the ID for Indiana of the ZHVI is `INUCSFRCONDOSMSAMID`. Next, download

medium income for the state of your choice. For example, the series ID for Indiana is `MEHOINUSINA646N`. Be very careful that you download the nominal time series (i.e., current dollars) and not the real values. Calculate an affordability ratio (e.g., housing price index over household income) from 1980 to the present. Analyze periods when affordability worsened most sharply and link them to macroeconomic events, e.g., 2008 financial crisis, COVID-19 pandemic. What else do you observe?

6. ***Pareto vs. Kaldor-Hicks Efficiency*** (**): Consider the following table. Does this project meet the criteria of Pareto efficiency? Kaldor-Hicks efficiency? Would it pass a majority vote?

Individual Resident	Individual Benefit	Cost Share
A	\$4,500	\$3,000
B	\$1,000	\$3,000
C	\$2,500	\$3,000
D	\$4,500	\$3,000
E	\$1,500	\$3,000
Total Benefit	\$14,000	\$15,000