



How to Teach an Oil Shock?

This paper presents a method for teaching the impact of oil shocks on marginal costs to introductory and intermediate undergraduate economics students. Marginal costs are derived from a basic production function with capital, labor, and material inputs. An oil shock affects material-input prices, with effects depending on production's energy intensity. Because oil shocks have historically been linked to recessions, the paper provides a pedagogical framework for connecting firm-level costs to macroeconomic outcomes. The approach is illustrated with an [interactive classroom tool](#) suitable for Principles students, while intermediate and advanced students can benefit from the formal analysis alongside the visualization.

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1. Introduction

Oil prices have affected the macroeconomy at least since World War II (Hamilton, 1983). The evidence of this effect has strengthened since the 1970s when recurrent energy price shocks have caused repeated episodes of stagflation (Abeyasinghe, 2001; Hamilton, 1996; Herrera, Karaki, & Rangaraju, 2019; Serletis & Xu, 2023). The current paper uses oil shocks to advance students' understanding of a complex concept such as marginal costs, which are typically taught as a central concept in many Principles of Economics and Microeconomics courses.

Marginal costs are central to these courses because they affect firm-level outcomes. Through aggregation, they also trigger macroeconomic outcomes, such as a rise in the overall price level and a fall in gross domestic product (GDP). The centrality of marginal costs for both firms' and, by extension, aggregate outcomes makes it important to teach marginal costs at a level that students find intuitive. Yet, they can be challenging for many, particularly those who had not been exposed to 'thinking at the margin' beforehand. Luckily, natural phenomena such as energy price shocks can help illustrate both the concept and its far-reaching implications.

Stankov (2018) argues that the underlying structure of marginal costs can naturally be used to teach factor price shocks. However, classic introductory texts have apparently left out the link between marginal costs and energy prices, e.g. Alchian and Allen (1965); Case and Fair (2007); Farnham (2009); Mankiw and Taylor (2014); Parkin (2004); Sloman (2006); CORE-ECON (2017), while more advanced texts, e.g. Varian (1992), and Mas-Colell, Whinston, and Green (1995) are more concerned with abstracting the general structure of a cost function rather than its practical applications.

As a result, economics students, and particularly those at the introductory level, rarely connect events on capital, labor or energy markets to optimization decisions at the firm level, which then have knock-on effects on the aggregate economy and policy making. This is a missed opportunity for economics teaching that the current paper seeks to address. As a central element of a firm's profit maximization, the firm's marginal costs become a natural object of interest.

In what follows, I present a brief conceptual introduction to marginal costs, the purpose of which is to expose introductory-level students to the intuition behind the formal derivations elsewhere in the paper. To accompany the intuition, I also present an interactive teaching tool to illustrate the changes in marginal costs when an oil price changes. Then, for the intermediate-level students, or introductory-level students with some math background, an intuitive derivation of the firm's marginal costs is presented. The derivation links the structure of marginal costs to events on factor markets, such as oil shocks. This naturally links to a discussion of aggregate outcomes and policy implications.

2. A Conceptual Introduction to Marginal Costs

When oil markets responded to the War in Iran in the Spring of 2026 with a sharp rise in the price of oil, economics instructors around the world knew this might affect inflation and aggregate output, particularly if the shock persisted. This was because geopolitical conflicts have a way of affecting the economy through their impact on the price of natural resources (Monge, Gil-Alana, Pérez de Gracia 2017), particularly when the resources are used intensively in the production of everyday goods. This is certainly the case with oil, whose price shocks have caused recessions and accelerated inflation at least since the 1970s (Serletis & Xu, 2023).

It is usually not hard to convince students that the price of oil could shock the economy, because a large part of the economy uses oil directly or indirectly in production. For example, crude oil prices have a direct impact on gasoline prices at the pump, which then have a knock-on effect on the transportation prices of products consumers buy. It also directly affects how much farmers pay for producing the essentials that students consume every day, because the machines they use typically run on diesel or petrol fuel. If farmers pay more for their fuel, it will cost them more to produce our food. The price they pay for their inputs to produce our food will then be passed on to the consumers along the value chain. In addition, oil has an indirect impact on almost everything else being produced – more so on goods which rely more heavily on transportation inputs, but also on the services we consume. For example, when the price of oil goes up, the cost of each delivery we order goes up with it. Therefore, even if we do not directly consume oil in our everyday lives, the things that we do consume have a certain fraction of their production costs that is due to the price of oil.

The production costs of any goods which students buy have several components. The most consequential ones are capital, labor, and material inputs. The material inputs typically include several sub-components, including transportation, electricity, or other items used with capital or labor to deliver the output (for example, farmers use fertilizers to prevent damage to their crops). Thus, the price of any of these three broad inputs – capital, labor and material inputs – affects total costs.

However, it is not only the price of the input that affects costs. Imagine a pizza restaurant that pays rent for the place, wages for the cook and waiters, and electricity for the oven and keeping the lights on. If the cook is more productive in producing pizzas, then each pizza will cost less to produce. For example, if the cook is paid \$15.00/hour and produces 5 pizzas in this hour, the labor costs associated with each additional pizza in that hour will be \$3.00. However, if the cook becomes more productive and can produce 10 pizzas per hour, each additional pizza will cost \$1.50. This will boost the restaurant's profits and will likely lead it to expand the supply of pizzas. Same logic applies if the restaurant operates a more productive oven. For the same loan that the restaurant took out to buy the oven, a more productive oven will produce more pizzas per hour. Consequently, the restaurant will make more money from each pizza sold. However, when wages go up or when loans become more expensive through a rise in interest rates, each pizza will cost more to produce.

The same logic applies to material inputs. If their prices rise, such as the price of tomato sauce, or electricity, water, or delivery costs, the restaurant will find itself producing more expensive pizzas. If it cannot affect the price of pizza that end customers pay, it will have to internalize the higher costs and will likely lower production because of lower profits. Alternatively, if each pizza is produced in an oven that saves energy, i.e., if the energy required to produce each pizza is lower, then the same pizza will cost less to produce, and the restaurant will find it profitable to increase the number of pizzas produced. As a specific example, an increase in the price of oil raises fuel costs, making third-party deliveries of key inputs like tomato sauce and cheese more expensive. In turn, this makes every additional pizza more expensive, which raises its production costs, shrinks the restaurant's profit, and is therefore likely to reduce its output.

The above example based on the production of pizzas in a restaurant extends to most goods and services consumed in the economy. This is because all goods and services use capital, labor and material inputs in their production. Therefore, we could extend the example to a generic good that uses these three inputs and analyze the impact of the changes in the input prices, factor requirements, or factor productivity on their optimal production.

To facilitate the discussion, an interactive teaching tool has been developed that focuses on the price of the material input alone and on the input requirement for producing an additional unit of the good. Creating the tool has been motivated by evidence of a positive impact of visualization tools on both student learning and learning experience (Calimeris & Kosack, 2024; Enz & Kassens, 2022; Halliday et al., 2024). The tool can be entirely used offline, allows for further development, and is freely available here: <http://doi.org/10.17632/38pmsmwbr9.1>. Using the intuition and the interactive tool, we can expand the discussion for the intermediate and advanced students with a formal pedagogical framework, which is presented in the following section.

3. The Structure of Marginal Costs

To formalize the above intuition, consider a firm producing output according to the following neoclassical production function:

$$(1) \quad Q = F(K, L, M),$$

where the quantity of output Q is a function of the quantities of capital (K), labor (L) and material inputs (M). As the oil price is directly linked to the cost of transporting Q to end customers, as well as transporting inputs to the firm, M is the input where the analysis of an oil shock can be positioned. Let the respective factor prices be p_K , p_L , and p_M , which the firm takes as given.

By definition, the total costs are:

$$(2) \quad TC(Q) = FC + p_K K(Q) + p_L L(Q) + p_M M(Q),$$

where $K(Q)$, $L(Q)$, and $M(Q)$ are the input demands for production factors, given factor prices and FC is the firm's fixed costs. Because marginal costs are defined as the increase in total costs associated with the additional unit of output, or $MC = \left(\frac{dTC}{dQ}\right)$, we can differentiate the cost function to analyze how underlying changes in factor quantities or prices affect marginal costs:

$$(3) \quad MC = \frac{dTC}{dQ} = p_K \left(\frac{dK}{dQ}\right) + p_L \left(\frac{dL}{dQ}\right) + p_M \left(\frac{dM}{dQ}\right).$$

For the sake of developing the students' intuition, let us assume that this is a general pedagogical discussion about the underlying structure of marginal costs, rather than a discussion of input adjustments at the profit-maximizing or cost-minimizing level of output. Consequently, we can focus on implications for marginal costs when only one input changes while others are held constant. Then, the factor requirements to produce the additional unit of output can be represented as the inverse of marginal productivities, $\left(\frac{dK}{dQ}\right) = \left(\frac{1}{MP_K}\right)$, and $\left(\frac{dL}{dQ}\right) = \left(\frac{1}{MP_L}\right)$, where MP_K and MP_L are the marginal productivities of capital and labor respectively. For teaching purposes, we keep $\left(\frac{dM}{dQ}\right)$ in Eq. (3) as is, because it tells students how much material input (such as energy or oil) is required for the additional unit of output. In other words, it shows the intensity with which M is used in the production of the additional Q . This may be more intuitive to students than the marginal productivity of a material input. With this, students are ready for the final expression for marginal costs:

$$(4) \quad MC = \frac{p_K}{MP_K} + \frac{p_L}{MP_L} + p_M \left(\frac{dM}{dQ}\right),$$

which allows for analyzing the implications of changes in individual factor prices, factor productivity or factor intensity shocks on the firm's marginal costs, when a single input price changes. The next section discusses the impact of an oil shock.

4. Oil shocks, marginal costs, and economics pedagogy

Popular introductory macroeconomics textbooks such as CORE Econ (2025) and others typically discuss correlative evidence of the impact of an oil shock on aggregate outcomes such as prices and output (see section 4.9 in CORE Econ, 2025). Eq. (3) provides a result that can be used to teach the causal mechanism behind the changes students see in the data, while Eq. (4) is a useful device to illustrate marginal costs and develop the companion teaching tool.

The causal mechanism runs through decisions at the firm level, which are driven by changes in marginal costs when factor prices, productivity or the input requirements (factor intensity of an additional unit of output) change. For example, an oil shock raises P_M , which directly increases MC . Given output prices, a rise in MC will then reduce the optimal quantity for the firm. As this happens for both perfectly and imperfectly competitive firms, the aggregate output will drop for any price level.¹ However, this means the entire aggregate supply shrinks, which is what introductory economics students are used to seeing in the classic AD-AS framework to explain stagflation.

An additional advantage of exposing students to Eq. (4) is that they immediately see the link between the factor requirement in the production of an extra unit of output, and the resulting marginal costs. For example, if oil is intensively used in production (e.g., a business is heavily reliant on transportation using fossil-fuel engines) then the impact of an oil shock on marginal costs, i.e. $\left(\frac{\partial MC}{\partial p_M}\right)$ will be large. This is because a rise in the price of material inputs affects marginal cost proportionally to this intensity (the marginal factor requirement):

$$(5) \quad \frac{\partial MC}{\partial p_M} = \frac{dM}{dQ},$$

which directly follows from Eq. (4). This result illustrates the basic intuition developed earlier in Section 2. Specifically, industries or firms relying more (or less) heavily on oil per unit of output will experience a larger (or smaller) increase in marginal costs when oil prices rise. Consequently, as economies shift from manufacturing to services, or from fossil fuels to cleaner energy sources, the oil requirement in the production of GDP falls (Baffes, Streifel, & Temaj, 2024; Bakhshi Moghaddam & Moshiri, 2025). According to Eq. (5), an oil shock will then exert a weaker influence on marginal costs, and by extension, on aggregate outcomes. This could serve well in explaining how many economies have become less elastic (in the language of a business student, more resilient) to oil shocks since the 1970s. Evidence of such mounting resilience is plentiful (Blanchard & Gali, 2007; Blanchard & Riggi, 2013; De Gregorio et al., 2007; Bakhshi Moghaddam & Moshiri, 2025)

Further, Eq. (4) can also be used to illustrate why some oil shocks have failed to cause recessions. By implication from Eq. (4), an oil shock can lead to a recession if it triggers a supply-side shock. However, some oil shocks are demand-driven and their impact on MC is far smaller, which explains their broadly weaker or time-varying influence on aggregate output (Kilian, 2009; Hailemariam, Smyth, Zhang, 2019). It is therefore important to note that, while upward supply side shocks may cause recessions, downward shocks are not bound to produce expansions (Hamilton, 2003). This asymmetry in the way oil shocks are affecting the macro economy also needs to be reflected in the policy discussions with students, as well as counter evidence favoring reverse causality (from the macro economy to resource prices), as argued by Barsky and Kilian (2004).

¹ For imperfectly competitive firms, the familiar profit maximization condition $p = MC$ is replaced by $MR = MC$. In this case, higher MC intersects with MR at a lower profit-maximizing quantity. The interactive visualization that comes with this paper only uses the $p = MC$ condition. However, as it is open-source, readers may extend it for imperfectly competitive firms if this suits their pedagogical goals.

An additional pedagogical value for both students and faculty may derive from the direct link between the oil or energy requirement measure $\left(\frac{dM}{dQ}\right)$ and the attempts to transition the economy away from fossil fuels. As the energy transition gains traction, the exposure of an economy to oil price shocks will be further eroded, which carries certain political advantages for the incumbent politicians (See Unit 15 in CORE Econ, 2017; Lewis-Beck & Stegmaier, 2000). The issues around environmental protection and energy transition are more likely to resonate with younger people, and therefore students may find the link between $\left(\frac{dM}{dQ}\right)$, marginal costs, cost of living and the environmental implications particularly rewarding.

Finally, although Eq. (4) leads to interesting macroeconomic implications, it masks varieties of responses across industries within countries and across countries, which may experience oil shocks differently. This reflects within-country variation in sectoral factor requirements, which emerges from Eq. (5) as varying marginal-cost responses to an oil shock. This comparative viewpoint proposed by Edelstein and Kilian (2007) and more recently advanced by Bakhshi Moghaddam and Lloyd-Ellis (2022) could further spur student interest in the many applications of oil shocks for the macro economy, most of which pass through the firm's marginal costs.

5. Conclusion

Recent advances in teaching macroeconomics have made the link between oil shocks and aggregate shocks more explicit (see, for example, sec. 4.9 and 4.10 in CORE Econ, 2025). However, the analysis does not explicitly relate to firm-level decisions, which I find more intuitive for students to understand with the help of the above exposition of marginal costs. This paper offers a way to improve our teaching of marginal costs using an oil shock, which current and future generations of students at different levels and their instructors might find equally helpful.

Statement on the use of AI

A generative artificial intelligence tool (Microsoft Copilot) was used in the preparation of this manuscript to assist with literature searches, improve exposition and clarity, check algebraic derivations, and generate the code for the interactive teaching companion tool. AI was not used to generate original ideas, data, or models. The analysis was developed and validated by the author, who takes full responsibility for the accuracy and integrity of the manuscript, including its teaching companion, at the time of publication.

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