Abstract:

I discuss a pedagogical strategy based on data visualization and analysis in the teaching of intermediate macroeconomics and financial economics. In these short projects students collect and manipulate economic data from the online Federal Reserve Economic Data (FRED) database in order to illustrate theoretical relationships discussed in class. All the data collection and manipulation tasks are conducted through the FRED website. I argue that as students locate and use effectively the quantitative information that they need to evaluate abstract concepts they are in effect developing the connection between theories and empirical evidence that underpins the discipline of economics.

Keywords: Intermediate Macroeconomics; Financial Economics; Data Manipulation; Data Analysis.

JEL codes: A22, C82, G12, G14, G15.

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Diego Méndez-Carbajo
As Simkins and Maier convincingly argue in their description of pedagogical strategies to improve student learning in the economics major, Bloom's higher-order cognitive processes (Bloom 1956) and Siegfried et al. "thinking like an economist" learning goals (Siegfried et al. 1991) are best achieved through learning that encourages students to "analyze trends and correlations in economic data, apply economic theory to real-world problems, and evaluate economic policies" (Simkins and Maier 2009, 85). The challenge, then, lies in designing course assignments that help students develop the intellectual proficiencies involved in "doing economics". In what follows I will argue that the web-based interface of the FRED database is an excellent resource for relating economic concepts and theories to data. The data-visualization and manipulation capabilities of the FRED website are significant pedagogical resources since they allow students to visualize and analyze economic data in real-time. This is particularly important in macroeconomics, where students often struggle to understand the "macro" reality. For example, introducing students to macroeconomic concepts through classroom exercises, where they analyze data on inflation or GDP growth rates, can help students develop a better understanding of macroeconomic trends. At the same time, I would argue that there is a large information deficit when it comes to the "micro" world of student decisions, such as choosing between choosing hours of study or hours of leisure. This information gap can lead to misperceptions and miscalculations in microeconomic terms. In my own experience, beginning-of-the-semester surveys on current inflation or GDP growth rates reveal great gaps in students' familiarity with these kinds of information. Efforts to make the material relevant and engaging through the use of examples and illustrations often fail to bridge this gap. For example, discussing opportunity cost in terms of hours of sleep versus hours of study can seem abstract to students. However, when discussing the opportunity cost of sacrificing sleep for study time, students are more likely to understand the concept and apply it to their own lives. This is because students are more familiar with the "micro" reality, where the decisions they make affect their own lives. It is crucial for instructors to use examples that are relevant to students' lives in order to make the material more engaging and meaningful. The FRED database is an excellent tool for introducing students to economic concepts and theories, as it provides a wealth of data that can be used to illustrate key economic principles. For example, analyzing data on inflation rates or GDP growth can help students understand the macroeconomic realities they face. By using the FRED database to teach economic concepts, instructors can help students develop a deeper understanding of the "macro" reality, while also providing them with the tools they need to "think in macroeconomic terms". This approach is consistent with the work of Hansen (Hansen 1986) and Colander and McGoldrick (Colander and McGoldrick 2009), who emphasize the importance of "educating economists" in the contemporary context. The FRED database is an excellent resource for achieving these goals.
The pedagogical approach that I propose employs data-visualization techniques in an intermediate macroeconomics or financial economics course. Visualization of economic models through diagrams enjoys a long tradition in the discipline. As Wilkina (Wilkina, 1992) endorses the use of the software package Mathematica to demonstrate and visualize through diagrams sophisticated economic models, Maclachlan et al. (2010) echo Wilkina’s view. However, whereas the aforementioned authors make data search and retrieval tasks central to the course assignments that they describe, the pedagogical strategy that I propose makes the tasks of finding and accessing data central to the students' work. The use of the Federal Reserve Economic Database (FRED) and online compiler reduces data searching costs in terms of time and energy. Moreover, its web interface makes data search and retrieval tasks marginal to the course assignments. Yet, whereas the aforementioned authors make data search and retrieval tasks marginal to the course assignments that they describe, the pedagogical strategy that I propose makes the tasks of finding and accessing data central to the students' work. The use of the Federal Reserve Economic Database (FRED) and online compiler reduces data searching costs in terms of time and energy.
The activities that I describe could also be used in conjunction with the case method teaching in economics that Velenchik and (Marks and Rukstad 1996) endorse in order to "understand the real world" [...] while mastering basic economic theory" (Velenchik 1995, 29).

In the context of this particular pedagogical strategy, the proposed data visualizations can be valuable assets in either drafting a case or in guiding the students' preparation for the case itself. In the course activity that I describe in the following sections students manipulate data series through the FRED website to quantify a series of macroeconomic concepts in the contemporary context of the United States economy.

THE COURSE

The course where I make the most extensive use of this pedagogical strategy is an elective financial economics course open to any student who has completed the introduction to economics course. There are no other prerequisites to this elective course. The class meets twice a week during a 14-week semester in a classroom equipped with a computer and a video projector. The course is organized around four units: (a) Stock Prices (4 class periods), (b) Exchange Rates (4 class periods), (c) Interest Rates (4 class periods), and (d) Financial Derivatives. At the end of the semester we also devote 3 class periods to Financial Derivatives.

During the first class period of the semester the students meet the academic librarian who serves to introduce the academic librarian to the students in order to encourage them to seek help with their research needs. This research instruction session also serves to introduce the students to the databases that they will use in their activities. The library subscribes to a number of specialized databases and although the students are not currently required to use any of them, I have found the public-access versions of some of them, Standard and Poor's NetAdvantage, for the first course unit I have found the public-access version of this database to be particularly useful. The library also subscribes to a number of specialized databases and although we use one of them, Standard and Poor's NetAdvantage, for the first course unit, I have found the public-access version of this database to be particularly useful.

In the course activity that I describe, students are introduced to the databases and are encouraged to seek the assistance of the academic librarian throughout the semester. The course is open to any student who has completed the introduction to financial economics course, and during the first class period of the semester the students meet the academic librarian who serves as the liaison with the Economics Department for a research instruction session at the library. The students are introduced to the databases that they will use in their activities and are encouraged to seek the assistance of the academic librarian throughout the semester.

The course objective is to familiarize students with the FRED database and to encourage them to gather the data for the graphing and analysis exercises. This research instruction session also serves to introduce the students to the databases that they will use in their activities. The library subscribes to a number of specialized databases and although the students are not currently required to use any of them, I have found the public-access version of Standard and Poor's NetAdvantage to be particularly useful.
Online FRED Database

The Federal Reserve Bank of Saint Louis' FRED database ideally suited for the purposes of this course. During the research instruction session at the library, students become familiarized with FRED's website and with the processes of plotting specific data series and "creating your own data transformations." This particular function allows the website user to algebraically manipulate the data on her/his browser, eliminating the need to download the data series into a spreadsheet in order to compute ratios, differences, and so on. Also during this class period, the students become familiar with the online teaching platform Moodle, locating the discussion questions for the data graphing and analysis exercises. All the course materials are available through the Moodle course page and students submit their work through this medium too. I personally find this particular feature of the course design very convenient and although student evaluations endorse it is not indispensable for the application of the pedagogical strategy that I describe here.

Currently, I have incorporated FRED-based graphing and analysis activities into the discussion of seven separate topics or concepts in my financial economics course. Table 1 lists the concepts, the data series & codes, and the data transformations that I employ. Each concept and topic is first presented through a lecture and immediately compared against its historical record in the United States. In order to do so, students are split into small groups and assigned a topic. For example, a topic like the term spread during different periods or different countries is analyzed. Each concept is then discussed in a step-by-step approach provided by the Moodle platform. Students submit their work through this medium too.

Table 1

<table>
<thead>
<tr>
<th>Concept</th>
<th>Data Series</th>
<th>Data Transformations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term Spread</td>
<td>T1, T2</td>
<td>Algebraic Manipulation</td>
</tr>
<tr>
<td>Sovereign Risk Premium</td>
<td>C1, C2</td>
<td>Data Transformation</td>
</tr>
</tbody>
</table>

This activity quantifies market-based inflation expectations, as reflected in Treasury security yields, over time. The activity can be used as either (a) an instructor-led illustration in which the instructor shows – either on paper or on a screen – the data and students analyze them, or (b) as a student activity in which students find the specified data. Instructors with less time could use option (a) and instructors interested in their students learning about the FRED database could use option (b). In order to highlight the replicability of this activity I will describe it as an instructor-led in-class demonstration.

### The Activity

1. Within the FRED website (https://research.stlouisfed.org/fred2/) the instructor will select the tab “Data Tools” and within that tab the “Create Your Own Graph” tool. Once the “FRED Graph” window opens, the instructor will present a graph of the 30-Year Treasury Inflation-Indexed Securities.

2. Within the “Add a Data Series” form, the instructor will select the following series:
   - **Series 1**: 30-Year Treasury’s Inflation-Indexed Bond Rate (WTP30A28) (Category: Money, Banking & Finance > Inflation-Indexed Securities)
   - **Series 2**: 30-Year Treasury’s Constant Maturity Bond Rate (DGS30) (Category: Money, Banking & Finance > Interest Rates)

3. The instructor will then “Add a Data Series > Add New Series”, graphing the 30-Year Treasury’s Constant Maturity Bond Rate and the 30-Year Treasury’s Inflation-Indexed Bond Rate.

4. The instructor will highlight the relationship between bond yield and bond price, discussing how it is possible that a bond offers a negative yield. Questions of volatility can also be brought up by pointing out sudden and large changes in the value of the series.

5. The instructor will then “Add a Data Series > Add New Series”, graphing the 30-Year Treasury’s Constant Maturity Bond Rate and the 30-Year Treasury’s Inflation-Indexed Bond Rate. Once the data is plotted the instructor can ask students to review the relationship between bond yield and bond price, discussing how it is possible that a bond offers a negative yield. Questions of volatility can also be brought up by pointing out sudden and large changes in the value of the series.

6. The instructor will then “Add a Data Series > Add New Series”, graphing the 30-Year Treasury’s Constant Maturity Bond Rate and the 30-Year Treasury’s Inflation-Indexed Bond Rate. Once the data is plotted the instructor can ask students to review the relationship between bond yield and bond price, discussing how it is possible that a bond offers a negative yield. Questions of volatility can also be brought up by pointing out sudden and large changes in the value of the series.

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12. The instructor will then “Add a Data Series > Add New Series”, graphing the 30-Year Treasury’s Constant Maturity Bond Rate and the 30-Year Treasury’s Inflation-Indexed Bond Rate. Once the data is plotted the instructor can ask students to review the relationship between bond yield and bond price, discussing how it is possible that a bond offers a negative yield. Questions of volatility can also be brought up by pointing out sudden and large changes in the value of the series.

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15. The instructor will then “Add a Data Series > Add New Series”, graphing the 30-Year Treasury’s Constant Maturity Bond Rate and the 30-Year Treasury’s Inflation-Indexed Bond Rate. Once the data is plotted the instructor can ask students to review the relationship between bond yield and bond price, discussing how it is possible that a bond offers a negative yield. Questions of volatility can also be brought up by pointing out sudden and large changes in the value of the series.
The instructor could point out that although there is frequent co-movement between the series, the yield of inflation-indexed Treasury securities rarely exceeds the yield of the non-inflation-indexed Treasury securities. The instructor can ask students to put forward an argument for why that is the case. Thus having introduced the concept of inflationary expectations, or—alternatively—that of an "inflation premium"—the instructor will proceed to quantify this concept.

In order to do so, the instructor will first "Edit Data Series 2" (30-Year Treasury's Constant Maturity Bond Rate (DGS30)) by deleting it [clicking on the trash can icon to the right of the series' name]. These steps are needed in order to have both series as part of the same database object and allow for their manipulation. This manipulation is accomplished by selecting "Create Your Own Data Transformation" and then "Formula > b – a > Apply".

The graph, see Figure 2, now plots the difference between non-inflation-indexed and inflation-indexed Treasuries, a computation of inflation expectations, and can be used to organize in-class discussions around questions such as these: What average value did inflation expectations have before the 2008-2009 recession? What are the implications of such stable expectations for bond prices? Consider both the magnitude and the volatility of inflation expectations after the 2008-2009 recession. What are the implications of such volatile inflation expectations for bond prices? Consider both the magnitude and the volatility of inflation expectations and can be used to discuss the impact of unconventional monetary policy on inflation expectations.
Before the presentation of the data and the ensuing discussion, instructors should allocate 20-30 minutes of classroom time. All FRED data plots can be saved into a "dashboard" in a "user account" and thus prepped ahead of class to save time. The recommended method for assessment of this course activity would be to have students write up a short memo where they discuss the historical evolution of inflation expectations computed as the difference between non-inflation-indexed and inflation-indexed Treasury bonds. This should be a take-home assignment. Finally, the richness of the FRED online data repository allows for further sophistication of this activity. For example, by plotting the difference between the 10-Year Treasury's Constant Maturity Bond Rate (DGS10) and the 10-Year Treasury's Inflation-Indexed Bonds (WTP10J14) students can discuss how and why 10-Year and 30-Year inflation expectations are different.

CONCLUSIONS

I have employed graphing and analysis exercises like the one described above in intermediate macroeconomics and financial economics courses over the last five years. Not having conducted a systematic evaluation of their pedagogical effectiveness my overall assessment is derived from a comparison of old and new-in-class practices and observed student behavior. In a forthcoming publication I present some evidence of improved test scores across assessment is derived from a comparison of old and new-in-class practices and observed student behavior. Having conducted a preliminary evaluation of the pedagogical effectiveness of these exercises I believe that bringing data into the classroom through the FRED database is a highly significant strategy. The ease of access to thousands of data repositories from the International Monetary Fund and the World Bank also includes means.

Between the presentation of the data and the ensuing discussion, instructors should allocate 20-30 minutes of classroom time. All FRED data plots can be saved into a "dashboard".
Incorporating this type of data graphing and analysis into an existing intermediate-level course may present some initial challenges to some instructors and students. As Velenchik points out, in an open-ended discussion the instructor has to guide the class through the process of distinguishing between good and bad ideas. This is a departure from the lecture being a “rhetoric on stage” but also an opportunity to empower students in their own learning. As for the opportunity cost of incorporating this type of data graphing and analysis into an existing course, I would also like to point out that the online visualization and manipulation of data series through the FRED website provides easy access to preliminary visual data analysis and frequency/unit manipulation. I would also like to point out that the FRED website provides easy access to preliminary visual data analysis and frequency/unit manipulation.
Online FRED Database


The value of connecting theory and data in our courses.

...discussion question into a fully-fledged, semester-long, research project speaks strongly of the omnipotent control of a course instructor. Besides unpredictable power outages, computer malfunctions and the like, the use of the FRED website ties its users to a continually growing and evolving data repository and visual interface. Although in a world of consumer electronics and professional software where new versions of operating systems and programs supersede old, I am not convinced that any family ever is exposed to the same need to adapt unexpected changes in the FRED website. Online FRED database...
Currently, I have incorporated a data-visualization exercise to each of the following seven topics in a standard intermediate macroeconomics course: (1) GDP components, (2) uses of data into Microsoft Excel for purposes of analysis.

During the first class period of the semester, the students meet the academic librarian who serves as the liaison with the Economics Department for a research instruction session at the library's computer lab. There, the students are introduced to the database that they will use to gather the data for the visualization exercises and are assigned to one of four different groups. This research instruction session also serves to introduce the academic librarian to the students in order to encourage them to seek her/his assistance with database needs throughout the semester. The students are introduced to the online teaching platform Moodle, locating the discussion questions for the quantitative case studies, and importing their work groups into Moodle. Each semester I identify four or five different countries for the students to work on the GDP components for the US, also becoming familiar with the online research platform in order to keep the data analysis and the size of the work groups manageable each semester. I have found this resource very convenient for the purposes of my course. In order to keep the data analysis and the size of the work groups manageable by the International Monetary Fund (IMF) database, I have found this resource very convenient for the purposes of my course.

The library subscribes to the International Financial Statistics (IFS) online database maintained by the International Monetary Fund (IMF) and I have found this resource very convenient for the purposes of my course. In order to keep the data analysis and the size of the work groups manageable by the International Monetary Fund (IMF) database, I have found this resource very convenient for the purposes of my course.
Online FRED Database

12

different countries’ data are compared. Some questions (e.g., "Who is the country with the largest GDP?") result in a comparison of economic structures when GDP is large, whereas other questions ask the student to describe visual aspects of the data (e.g., "Which GDP data are very large in magnitude (e.g., Brazil’s hyperinflationary experience)?") and preferential difficulties arise for students because of matters germane to social-scientific information literacy. For example, the methodology of data collection, or even a change in the definition of the object of study (e.g., Germany pre-and-post 1990), result in discontinuities in the data sets that students are asked to compare.

After the data is plotted, students use the graphs they have generated to answer a series of discussion questions highlighting how quantitative evidence validates—or sometimes challenges—the theoretical relationships that students have demonstrated in the class. These questions are posted on an online discussion forum hosted on the Moodle teaching platform. Only students registered in the course have access to these questions and answers are set up in a "Q&A" format, which prevents students from seeing their peers’ answers and, therefore, ensuring that they are solving the questions on their own. The discussion questions prompt students to think critically about the data they have collected, plotted, and analyzed and to reflect on the implications of their findings for the field of macroeconomics.

These educational opportunities to develop a historical context to the study of macroeconomics are sometimes frustrating for students because of matters germane to social-scientific information literacy. For example, the methodology of data collection, or even a change in the definition of the object of study (e.g., Germany pre-and-post 1990), result in discontinuities in the data sets that students are asked to compare.
3

The concept of quantitative literacy, or numeracy, becomes central to the course. As the students work through the different countries, they are able to observe different orders of magnitude, proportion and sign associated with the data being analyzed. Also, the same discussion question is addressed across the different countries, which helps the students gain confidence in reading and interpreting the data. The in-class discussion period allows the students to see how to produce a certain degree of peer pressure that marginally improves the overall quality of their work. Moreover, I believe that the fact that students see their work projected for everybody to see encourages the development of a healthy competitive environment. Over the last three years, I have made use of a technology-intensive classroom setup with multiple video projectors and a digital whiteboard. These are key components of this activity, but they rely heavily on the visualization of trends, cycles and degrees of association between productivity and the unemployment rate. These are not essential components of this activity, but they rely heavily on the visualization of trends, cycles and degrees of association between productivity and the unemployment rate. These are key components of this activity, but they rely heavily on the visualization of trends, cycles and degrees of association between productivity and the unemployment rate. These are key components of this activity, but they rely heavily on the visualization of trends, cycles and degrees of association between productivity and the unemployment rate. These are key components of this activity, but they rely heavily on the visualization of trends, cycles and degrees of association between productivity and the unemployment rate.
increases. Their “micro” thinking, discussed earlier in this paper, leads them to conclude that employers demand fewer workers once these workers become more productive.

In the fall semesters of 2009 and 2010, prior to the inclusion of data-visualization exercises, I asked students to identify in a diagram the impact of an increase in total factor productivity on output and on the marginal productivity of labor. Although the standard deviations of the post-quantitative case study test scores have increased from 0.15 to 0.25, due to the small size of the populations under study, one could argue that the students were able to answer the skill pyramid representing Bloom’s (1956) taxonomy of learning objectives. Nevertheless, one should attribute these improvements to the skill pyramid representing Bloom’s (1956) taxonomy of learning objectives rather than to replication of the population under study. The average scores on these specific questions dropped from 75% to 44%. In fact, as students were asked to analyze information, rather than to replicate material covered in class, they struggled when confronted with the task of evaluating a reporter’s statement contrasting theoretical responses. In general, the students displayed their knowledge of the concepts at stake through a production of facts, not through replication of the graphs discussed in class, they struggled when confronted with the task of evaluating a reporter’s statement contrasting theoretical responses. In general, the students displayed their knowledge of the concepts at stake through a production of facts, not through replication of the graphs discussed in class, they struggled when confronted with the task of evaluating a reporter’s statement contrasting theoretical responses. In general, the students displayed their knowledge of the concepts at stake through a production of facts, not through replication of the graphs discussed in class, they struggled when confronted with the task of evaluating a reporter’s statement contrasting theoretical responses. In general, the students displayed their knowledge of the concepts at stake through a production of facts, not through replication of the graphs discussed in class, they struggled when confronted with the task of evaluating a reporter’s statement contrasting theoretical responses. In general, the students displayed their knowledge of the concepts at stake through a production of facts, not through replication of the graphs discussed in class, they struggled when confronted with the task of evaluating a reporter’s statement contrasting theoretical responses. In general, the students displayed their knowledge of the concepts at stake through a production of facts, not through replication of the graphs discussed in class, they struggled when confronted with the task of evaluating a reporter’s statement contrasting theoretical responses. In general, the students displayed their knowledge of the concepts at stake through a production of facts, not through replication of the graphs discussed in class, they struggled when confronted with the task of evaluating a reporter’s statement contrasting theoretical responses. In general, the students displayed their knowledge of the concepts at ease...


Online FRED Database.
<table>
<thead>
<tr>
<th>Concept</th>
<th>Data Series and Codes</th>
<th>Data Transformation</th>
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</thead>
<tbody>
<tr>
<td>Purchasing Power Parity</td>
<td>(a) Japan / U.S. Foreign Exchange Rate (DEXJPUS)</td>
<td>c/b</td>
</tr>
<tr>
<td></td>
<td>(b) Consumer Price Index for All Urban Consumers: All Items (CPIAUCSL)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(c) Consumer Price Index of All Items in Japan® (JPNCPIALLMINMEI)</td>
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</tr>
<tr>
<td>Corporate Risk Premium</td>
<td>(a) Moody’s Seasoned Baa Corporate Bond Yield (BAA)</td>
<td>a-b</td>
</tr>
<tr>
<td></td>
<td>(b) Moody’s Seasoned Aaa Corporate Bond Yield (AAA)</td>
<td></td>
</tr>
<tr>
<td>Inflation Expectations</td>
<td>(a) 30-Year Treasury’s Constant Maturity Bond Rate (DGS30)</td>
<td>a-b</td>
</tr>
<tr>
<td></td>
<td>(b) 30-Year Treasury’s Inflation-Indexed Bonds (WTP30A28)</td>
<td></td>
</tr>
<tr>
<td>Sovereign Debt Risk</td>
<td>(a) Interest Rates, Government Securities, Government Bonds for Spain (INTGSBESM193N)</td>
<td>a-b</td>
</tr>
<tr>
<td>Premium</td>
<td>(b) Interest Rates, Government Securities, Government Bonds for Germany (INTGSBDEM193N)</td>
<td></td>
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<tr>
<td>The Interest Swap</td>
<td>(a) 10-Year Swap Rate (MSWP10)</td>
<td>a-b</td>
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<tr>
<td>Spread</td>
<td>(b) 10-Year Treasury’s Constant Maturity Rate (WGS10YR)</td>
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<tr>
<td>Nominal and Real</td>
<td>(a) 30-Year Conventional Mortgage Rate (MORTG)</td>
<td>a-b</td>
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<tr>
<td>Interest Rates</td>
<td>(b) Consumer Price Index for All Urban Consumers (CPIAUCSL) (Unit: Percent Change)</td>
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<tr>
<td>Taylor Rule</td>
<td>(a) Effective Federal Funds Rate (FEDFUNDS)</td>
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<td></td>
<td>(b) Consumer Price Index for All Urban Consumers (CPIAUCSL) (Unit: Percent Change)</td>
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<tr>
<td></td>
<td>(c) Civilian Unemployment Rate (UNRATE)</td>
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</tr>
<tr>
<td></td>
<td>(d) Natural Rate of Unemployment (Long-Term) (NROU)</td>
<td></td>
</tr>
</tbody>
</table>

**Table 1**: Economic Concepts and Data Visualization through FRED
**Figure 1:** Yield on 30-Year Treasury’s Inflation-Indexed Bonds (WTP30A28) and Yield on the 30-Year Treasury’s Constant Maturity Bond Rate (DGS30)
**Figure 2**: Spread between the 30-Year Treasury’s Constant Maturity Bond Rate (DGS30) and the 30-Year Treasury’s Inflation-Indexed Bonds (WTP30A28).