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Macroeconomic susceptibility, inflation, and aggregate supply

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HIGHLIGHTS

- Aggregate-supply curve specifications are unified using macroeconomic susceptibility.
- This formalism simplifies and generalizes the description of inflation dynamics.
- The role of expectations in inflation formation is reinterpreted.

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ABSTRACT

We unify aggregate-supply dynamics as a time-dependent susceptibility-mediated relationship between inflation and aggregate economic output. In addition to representing well various observations of inflation–output dynamics this parsimonious formalism provides a straightforward derivation of popular representations of aggregate-supply dynamics and a natural basis for economic-agent expectations as an element of inflation formation. Our formalism also illuminates questions of causality and time-correlation that challenge central banks for whom aggregate-supply dynamics is a key constraint in their goal of achieving macroeconomic stability.

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1. Introduction

The relationship between aggregate economic output and inflation known as the aggregate supply curve (ASC) is one of the most important and enigmatic relationships in macroeconomics [1,2]. The importance of the ASC comes from its central role as the constraint on the action of central banks in their quest to achieve price stability and low unemployment [3].[1] The enigmatic reputation of the aggregate supply curve has developed over time as a narrative of how those who have sought to use it in macroeconomic policy often found their efforts thwarted.[2]

Although the ASC is commonly based on with the work of Phillips [10] the economics of how aggregate economic output (output) and inflation interact as it is understood today [1] was developed decades earlier by Fisher [11]. An undeveloped aspect of Fisher's work, and the focus of this paper, is that the economics Fisher developed maps directly onto what one

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[1] In New-Keynesian macroeconomics the ASC is one of three elements at the core of macroeconomic dynamics; the other two element being (i) a model of aggregate demand and (ii) the loss function of a central bank that seeks to minimize the deviation of aggregate output from potential output and the deviation of actual inflation from target inflation (see, for example, Refs. [4,5], and [6]).

[2] See Refs. [1,3,7] and references therein for examples of this narrative, and Refs. [2,8,9] for an engaging presentation of the ahistorical nature of an important portion of this narrative.

would recognize as a susceptibility-based formalism with a response (or Green's) function quite similar to the Lorentz form of susceptibility commonly employed in optical and condensed-matter physics. The purpose of this paper is to develop Fisher's insight as a susceptibility-based theory of macroeconomic dynamics, to show that the various versions of the ASC in current use are special cases of this theory, and to provide a framework for understanding the enigmatic causality that attends fiscal and monetary policy based on the ASC.

To this end we begin with a translation of Fisher's economics into susceptibility-mediated response theory and validate this translation by demonstrating that it can reproduce Fisher's key results.[3] We then reframe Fisher's insight as a modern susceptibility-based theory and show that with this reframing a derivation of the modern ASC is straightforward and that important differences in economic interpretation of the ASC are revealed by this econophysical perspective. We close with a discussion centering on how this theoretical perspective provides a more complete and compact statement of the relationship between output and inflation that illuminates clearly what has often been seen as the enigmatic nature of the ASC, simplifies considerably the derivation and interpretation of this relationship, and illustrates the challenge that attends those who employ the ASC in a predictive policy manner.

2. The econophysics of inflation

Like many economists of the early 20th century Fisher employed a narrative and graphical approach in his work on the ASC. Consequently, quantitative understanding of Fisher's results requires both an inferring of the equation(s) that he likely used from a close reading of his description of the economics and a validation of that inference through reproduction of his graphical results with data that most closely matches that which he used.[4]

Fisher was agnostic concerning the mechanism linking changes in output and inflation; a perspective that separates Fisher from essentially all who preceded and followed him in this line of inquiry. The common approach to linking inflation and output is to first posit the primary source of inflation (almost always taken to be wage inflation), to then link this to a measure of stress in the economy (almost always taken to be unemployment), and to then connect unemployment to output through the linear relationship known as Okun's law [13]. Though popular, this approach leaves one exposed to the rise in importance of other sources of inflation as was seen with oil-price shocks during the 1970s. Fisher, by contrast and consistent with how the ASC is used in modern macroeconomics, simply looked for a relationship between inflation and output.

Fisher obtained this relationship from two time series: "P, the index number of wholesale prices of the United States Bureau of Labor Statistics and T, the Index of trade of Professor Warren M. Persons" from 1915 to 1923 since "[t]his period seemed the most suitable for the purpose (namely to obtain the best estimate of the true influence of price changes on business) chiefly because, during this period, the price changes were so great". Transforming the price time series into what we would now call inflation (and to which Fisher refers as P') using a centered difference, Fisher observed that the Index of trade time series "copies" the inflation time series closely with changes in trade following changes in inflation "with a few months lag".

The lag between the trade and inflation time series was investigated by Fisher in two ways. First, he calculated their correlation for a range of monthly offsets and found a maximum correlation of 72.7% associated with a lag of seven months. He then found that by using a distributed lag the correlation rose to 94.1%. This distributed lag was effected by using the lognormal density as a susceptibility function and, although it was not identified as such by Fisher, may be the first example of a modern response-function perspective in macroeconomics. The modern nature of his analysis together with the high correlations that he reports prompts one to ask whether this result can be reproduced with our current understanding of data from that period, and it is to this question that we now turn.

To explore the reproducibility of Fisher's results we employed two currently available time series – the Producer Price Index (PPI) for all commodities[5] and the Index of Trade and Industrial Activity for United States[6] – for P and T respectively. Our reproduction of Fisher's primary data is shown in panel (a) of Fig. 1. The time series in this figure reproduce those of Fisher's Chart 1 quite well. For PPI all of the major features are reproduced including locations of major slopes, plateaus, and overall dynamic range. The output time series differs somewhat from that shown in Fisher's Chart 1, as his (i) was "corrected for secular trend and seasonal variation" and (ii) "covers only basic commodities such as pig iron production, cotton consumption, employment and freight", while ours covers all commodities. Nevertheless, our output time series shares many of the important temporal signatures seen in Fisher's Chart 1. Finally, and importantly, our calculated inflation time series matches closely many of the high-frequency features (e.g., peaks bracketing 1917 and dynamic range) and low-frequency features (e.g., general level and drop/recovery seen in 1920–1921) of Fisher's Chart 1.

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[3] The reproducibility of these results is by no means a foregone conclusion. For an illuminating comparison of reproducibility in the social and natural sciences see Ref. [12].

[4] Obtaining the same data that Fisher used is complicated by the vagueness of his data-source citations.

[5] US Bureau of Labor Statistics, *Producer Price Index: All Commodities* [PPIACO], Federal Reserve Bank of St. Louis https://research.stlouisfed.org/fred2/series/PPIACO/.

[6] National Bureau of Economic Research, *Index of Trade and Industrial Activity for United States* [M1205AUSM156SNBR], Federal Reserve Bank of St. Louis https://research.stlouisfed.org/fred2/series/M1205AUSM156SNBR/.