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Fiscal policy and business cycle characteristics in a heterogeneous agent macro model☆

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ABSTRACT

This paper explores the macroeconomic implications of changing fiscal policy in a Heterogeneous Interacting Agent ("HIA") model. The key contributions to the existing HIA complex adaptive trivial system ("CATS") literature include the addition of a progressive income tax structure, an expanded role for redistribution, and a stylized reactive government sector. In certain specifications deficit financed tax cuts are shown to effectively shorten recessions, while deficit financed spending stimulus is able to lengthen recoveries. Alternative specifications provide ambiguous support for generalizing the effectiveness of these policy treatments. Robustness checks support the general findings that increased redistribution towards the unemployed results in higher unemployment rates, greater inequality, and shorter contractions.

1. Introduction

Theoretical heterogeneous interacting agent ("HIA") models are increasingly being used as an alternative to general equilibrium models to examine aggregate economic activity and macroeconomic policy questions. Previous examples of policy-based macroeconomic HIA models include Russo et al. (2007) who showed how government transfers can impact R&D and growth, as well as Delli Gatti et al. (2005b) and Giulioni (2007) who examined the role for competing monetary policy rules.[1]

The HIA macroeconomic modeling approach has also been used to help explain the process of collapse and contagion (Battiston et al., 2007, 2012; Delli Gatti et al., 2010b). In this context, agent-based models may provide insight regarding policies to slow contagion and reverse business cycle contractions. The recent crises in the U.S. and Europe underscore the desire of policy makers and the public for the government to react when a downturn occurs.

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[1] Fagiolo and Roventini (2012) discuss a variety of agent-based models (e.g., (Dosi et al., 2006, 2008, 2010)) where a government sector which redistributes income plays a role in both fostering growth and dampening cycles. Dosi et al. (2010) extends their previous work to account for an explicitly modeled government sector which results in higher growth and more stable fluctuations.

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Previously developed HIA complex adaptive trivial system ("CATS") models demonstrated an ability to replicate realistic business cycle features (Gaffeo et al., 2008), and showed that redistribution of revenues to the unemployed reduced growth, while government spending on R&D increased growth (Russo et al., 2007). This paper explores the potential effectiveness of fiscal policy actions conducted by expanding on these previously developed policy-based models.[2] The key additions include a reactive government sector, progressive income tax policy, and flexible redistribution. This paper examines how differing fiscal plans might impact the longest contractions, as well as the role fiscal policy plays in shortening business cycles in an agent-based model.

A reactive government sector operates by changing fiscal policy during extended contractionary phases of the business cycle. Relative to a baseline specification without a reactive government sector, three treatments are applied: a fiscal stimulus paid for through borrowing; a tax reduction accompanied by spending cuts; and a deficit financed tax cut that holds spending fixed. Consistent application of the various treatments suggest that a policy of deficit funded tax cuts manages to shorten recessions relative to the baseline specification while substantially reducing the number of long contractions. A policy of deficit financed spending is able to lengthen expansions relative to the baseline specification. There is also evidence that increasing redistribution to the unemployed raises the average rate of unemployment but is not inherently growth reducing.

The primary baseline specification is selected from a simple calibration against recent U.S. macroeconomic data. Several alternative specifications are examined and small changes to key parameters reverse or dampen many of the conclusions drawn from the baseline specification. A number of robustness checks confirm that these policy choices cannot be generalized. While this reiterates the need for further work in agent-based modeling, it is not surprising that differently specified models require different treatments.

Section 2 contains a discussion about the basic HIA model employed here, and outlines the theoretical mechanisms of the baseline specification. Section 3 describes the method of calibrating the baseline specification. Section 4 examines the policy treatments applied to the baseline specification as well as robustness checks, and Section 5 concludes.

2. CATS model

There are a wide variety of HIA-CATS models which each tend to have a specific focus. The model employed here is a unique variant on the HIA models used by Gaffeo et al. (2008), Delli Gatti et al. (2005b), and Russo et al. (2007) who model production as a linear function of labor.[3] CATS models have been shown to exhibit self-organizing stable states as well as conditions where small idiosyncratic shocks may push an economy into instability. Delli Gatti et al. (2008) and Gaffeo et al. (2007) describe CATS as sequential economies founded on bounded rationality which result in spontaneous market order.[4] CATS models are built on the foundation of individual rule-based behavior in a market environment, but lack a centralized solving mechanism that would be observed in a general equilibrium model. The CATS model is designed with sequential decision making using decentralized markets for labor and goods. Adaptive behavior is built into the model as agents use new information to update their satisficing rules in manner that is backward-looking, sequential, and path dependent (Gaffeo et al., 2007).[5]

This paper builds on the research of Russo et al. (2007) by adding a progressive income tax system. Progressive income tax systems are a primary source of government revenue and redistribution in many developed economies. The structure of this model is similar to that used by Russo et al. (2007) who redistribute all government revenues to either unemployed individuals or to firms for research and development ("R&D"). This model allows for redistribution to occur in a way that money can flow to both households or firms in the same simulation.[6]

The model adapted for use here is stock-flow consistent with respect to firm equity, transactional, and government cash flows. When firms fail due to bankruptcy, not only do households lose their source of income, but their wealth is negatively

[2] As noted by Marks (2007) the HIA approach is more of an exploratory tool than a prediction tool. This paper focuses on trying to understand what the model reveals in its emergent behavior and what these revelations suggest in terms of policy action.

[3] In contrast, other heterogeneous agent-based models like those proposed by Delli Gatti et al. (2008), Delli Gatti et al. (2005a), Gallegati et al. (2003a), and Battiston et al. (2007) model production as a linear function of capital only. Delli Gatti et al. (2005a) and Giulioni (2007) use capital in production, and also have endogenous entry and exit so the number of firms can grow over time. Growth in the number of firms over time is somewhat novel relative to the other articles in the HIA-CATS literature. Delli Gatti et al. (2005a) and Giulioni (2007) have no labor market, and therefore no way of capturing unemployment changes or the impact of taxes on labor income. Another CATS model with potential to extend the research presented here is by Delli Gatti et al. (2005b) who uniquely model output as a function of capital and labor, where capital is a direct reflection of total net worth. Delli Gatti et al. (2005b) designed their model to specifically explore central bank behavior and responses.

[4] Delli Gatti et al. (2008) and Delli Gatti et al. (2007) describe and display numerous stylized facts that the agent-based approach can explain which representative agent general equilibrium models cannot. CATS models typically result in scale-free distributions observed in empirical data such as power laws in wealth, firm size, and income. Additionally, CATS models are able to display long periods of both high aggregate volatility and tranquility like those observed in most advanced economies before, during, and after the Great Moderation.

[5] An example of satisficing behavior might be a worker looking for a job with a wage that exceeds their reservation wage. Any job offer which pays as much as or more than a worker's reservation wage could result in matching a worker to an employer. Thus, rather than searching for the highest possible wage, satisficing behavior assumes that a worker can accept the highest wage available to them within search constraints. This behavior can be applied to product, wage, and financial markets.

[6] Government redistribution of income to the unemployed has also been employed in work by Dosi et al. (2010).