Unwinding ZIRP: A simulation analysis

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ABSTRACT

This paper sets up a zero interest rate policy (ZIRP) experiment, using a two-market agent-based simulation model, in order to analyze the price dynamics of a large and small stock market during the unwinding of a simulated ZIRP. Different unwinding paths are created to determine which path has the most stabilizing impact on both the large and small stock market. Results indicate, that increasing the interest rate every three months create significant financial crises and negative stock market returns. However, increasing the rate every year leads to only modest declines in the large and small stock market. Moreover, the size of the interest rate change plays a much smaller role then the frequency of the rate changes. Rate increases every quarter creates 20% market corrections in the large market during the unwinding phase, as opposed to 4% downside when rate changes occur once a year.

1. Introduction

The US Federal Reserve has maintained a zero interest rate policy (ZIRP) for almost a decade. Never before in the history of US monetary policy has the Federal Reserve Bank (Fed) kept interest rates at zero for so long and then attempt to increase them. Given this new era of monetary policy it is hard to predict how unwinding ZIRP will play out in the global financial markets. It is impossible to learn from past policy mistakes in regard to ZIRP as no US historical data exists. The best the Fed can do is monitor economic data as we go and decide the best policy maneuver. Given the lack of historical data, I attempt to better understand the potential consequences of unwinding ZIRP on the global stock markets using simulation techniques.

More specifically I use an agent-based model to simulate two stock markets, a large developed stock market, meant to mimic the US stock market, and a small stock market, meant to mimic a portfolio of various emerging markets. I use Feldman’s (2010) two market agent-base model as the base model. In the base model there exists two markets with two sets of local investment managers and one set of global managers. Each set of local managers invest purely in their local market where as the global managers may invest in both markets. Feldman (2010) finds large global financial crises develop when global investment managers enter the picture and price risk based on behavioral biases as opposed to pricing risk using volatility. There are two reasons why I use Feldman’s simulation model. First, the global manager model creates on average one global financial crisis per century allowing a researcher to create a ZIRP experiment.1 The ZIRP experiment involves adding a central bank that is programmed to decrease the US mimicking market interest rate to zero after a global financial crisis. The central bank keeps the interest rate at zero for ten years before increasing the rate back to the original rate set prior to the global financial crisis. Second, the global manager model can create an environment akin to today’s environment, where the interest rate is low in the US market and high in the emerging market portfolio. Therefore, the global manager can hold onto cash in order to earn a high interest rate in the emerging market.

I hypothesize that the global manager linkage may create a dis-allocation as the global managers either use too much leverage,
borrowing at the zero interest rate, or flood the smaller market with too much capital trying to earn the higher interest rate. The consequence of unwinding ZIRP could undue this dis-allocation sending both markets into financial crisis. I test this hypothesis by analyzing crash frequency and return moments during the unwinding of ZIRP period. In addition, I explore various central bank unwinding paths in order to search for the unwinding path that creates the most stability across both stock markets. The unwinding paths differ based on the size of the interest rate increase, either twenty-five of fifty basis points (bps) increase, and the frequency of the rate increases, either every quarter, six months, or twelve months.

The main contribution of the paper is the addition of the central bank authority to the (Feldman, 2010) model and the setup of the ZIRP experiment. No central bank is created for the emerging market and therefore its interest rate stays constant throughout the simulation. A central bank is created for the US inspired market which is meant to mimic the Federal Reserve Bank of the United States. When the central bank lowers the rate for the US market this creates a large interest rate spread between the two markets that mimics actual financial markets. In addition, the original 2010 model is altered in that there exists two different interest rates as opposed to one interest rate.

Analysis points out several main results. First, I find increasing the US interest rate by 50 bps, as opposed to 25 bps, made a marginal difference when the rate change occurs every twelve months. In other words, I find that the frequency of the rate changes played a much larger role then the size of the rate change. In addition, increasing the interest rate too soon created significant downside, with US returns falling 20% (35%) on an annual basis during the unwinding period when increasing the rate every quarter by 25 (50) bps. However, US returns only fall by 4% (9%) on an annual basis during the unwinding period when increasing the US rate every year. Lastly, emerging market returns did not experience high crash frequency because of the unwinding of ZIRP. However, returns did decrease overall because of the interest rate intervention. I find no basis to suggest that emerging markets are more prone to a financial crisis because of the ZIRP.

2. Existing literature

Westeroff (2008) argues that agent-based models may be used as artificial laboratories to improve our understanding of how regulatory policy tools function. Napoletano et al. (2012) also argue that agent-based models (ABMs) allow one to explicitly account for phenomena such as heterogeneous beliefs and the emergence of bubbles and crashes. In addition, they add that ABMs allow one to model elements of real economic structures such that policy-makers can use in order to improve the guidance of policy-making applied to particular contexts. It is for these reasons that I use an ABM to investigate different monetary policies in regard to unwinding ZIRP.

There have been some examples of authors using ABM to better understand monetary policy. Rapaport et al. (2009) use an ABM where heterogeneous countries decide whether to introduce central bank independence taking into account the behavior of their neighbors. Arifovic et al. (2010) use an ABM where the agents can either believe the inflation rate announced by the central bank or employ an adaptive learning scheme to forecast future inflation. Computer simulations of this model show that the central bank learns to sustain an equilibrium with a positive, but fluctuating fraction of believers.

However, there is no research to date exploring the impact of unwinding ZIRP across multiple markets using ABM. Given the structure of how ABMs work, it makes sense to create this experiment using a global stock market ABM. I use the (Feldman, 2010) ABM which was developed from Friedman and Abraham’s (2009) single market model. Friedman & Abraham develop a single market agent-based framework focused on fund managers, where bubbles and crashes occur when investors price risk based on behavioral biases. Friedman & Abraham show the behavioral element in the ABM is the main factor to create bubbles and crashes. Feldman develops the Friedman & Abraham model into a two-market model where global managers may invest across both markets. Feldman finds that when global managers are added to the two-market model, they take on excessive leverage. The reason being is that ability to diversify across two markets lowers their risk perception in a behavioral model and leads to greater leverage taking as they feel safer from diversifying. The result is that large global financial crises can develop as a small shocks leads to a fast deleveraging across both stock markets.

3. Base model

There exists two populations of local managers who buy and sell a riskless asset with constant return \( r_m \) and a single risky asset with variable return \( R_m \). The local manager in market one, the large market, earns \( R_1 \) and the local manager in market two, the small market, earns \( R_2 \). Each fund manager chooses to allocate \( u_m \) that represents the percentage devoted to the risky asset, where \( m \) signifies either market one or two. If \( u_m < 1 \), it means the fund manager is partially invested in the risky asset and partially invested in the risk free asset, \((1-u_m)\). If \( u_1 = 1 \) the fund manager is fully invested in market one’s risky asset and if \( u_1 > 1 \) the managers is borrowing the risk free asset to invest in market one’s risky asset. The manager’s net portfolio value is denoted by the variable \( z_m \).

The fundamental value of the risky asset, \( V = e^{\delta g_{m,t}} \), is based on future earnings that are discounted at some rate \( R_s > g_{m,t} \) where \( g_{m,t} \) is the growth rate for market \( m \) at time \( t \). The price of the risky assets turn out to be

\[
P_m = V^{\delta} \pi_m.
\]  

(1)

The price is equal to, less than or greater than fundamental value whenever the average demand, \( \pi \) is equal, less than or greater than 1.0. The average demand, \( \pi_m \) is calculated by averaging the most recent allocation, \( u_0 \) across all managers weighting by their portfolio size, \( z_m \) in market \( m \). The average allocation, \( \pi \) represents buying pressure where the intensity is parametrized by \( \delta \).
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