Markups, Dynamic Demand Curves, News Shocks, and Business Cycles

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Abstract

This paper proposes a model to explain how positive news shocks result in current expansions. The main element of the model is the inclusion of internal deep habits, that is, good specific habits (à la Ravn et. al. (2006)). The internal deep habits generate a dynamic demand structure that provides a forward looking component to the model, and helps link future expectations to current actions, specifically positive news shocks to current expansions. The three main contributions of this paper to the literature are: (1) in addition to generating increases in output, consumption, investment, and labor hours in response to positive news about the future, the model also generates positive movements in real wages, and negative movements in marginal cost markups; (2) the dynamic demand structure provides an intuitive forward looking explanation that has firm groundings in anecdotal evidence from the data, for how and why future expectations positively affect economic agents’ decision making today; (3) the dynamic demand structure explains and generates positive sectoral co-movements in output, labor hours, and real wages between downstream sectors that are experiencing a news shock and upstream sectors that are not experiencing a news shock, the so called spill-over effect.

J.E.L. Classification: E3.

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1 Introduction

The rapid economic growth of the late 1990’s and the subsequent economic slowdown of the early 2000’s has generated much interest among economists, with the common belief being that expectations about the future played an important role in both the initial acceleration, and the subsequent rapid deceleration of the economy in that period. In recent years this belief has caused a resurgence of interest in the role news and expectations play in the creation of business cycle fluctuations. Unfortunately, with the standard neoclassical growth model failing to generate expansions in response to positive news about future productivity, much of this recent interest has centered around understanding what features of the economy cause positive future expectations to translate into economic expansions today. This paper, in particular, attempts to explain the late 1990’s economic expansion by illuminating the role of dynamic demand curves - a demand structure where current demand depends not only on current prices but also on past consumption and future prices - and the channel these curves provide for future expectations to affect aggregate variables today.

The idea that news and expectations about the future play a role in creating business cycles was first introduced long ago in the works of Pigou (1927), and these types of business cycles have often been referred to as ‘Pigou Cycles’ in the literature. The creation of a ‘Pigou Cycle’ begins when agents in the economy react to positive news about the future, and in doing so create an economic ‘boom’. At some point in the future this news may turn out to be overly optimistic, causing the agents to self-correct, and create an economic ‘bust’. In this way expectations and news have the potential to form one complete business cycle fluctuation, in the absence of any real productivity shock. The late 1990’s analogy would be of an economy where a strong belief in the potential of new and upcoming technologies, such as the internet, existed - the creation of the ‘dot.com boom’. However, the early 2000’s saw an adjustment in these beliefs from an over-exuberance about the potential of ‘dot.com’ companies in all sectors of the economy, to a more realistic ‘dot.com’ companies have potential in some sectors - the self-correction phase, which resulted in the economic downturn at the beginning of the new millennium.

The idea that business cycle fluctuations can be driven by news and expectations seems quite plausible. However, the standard neoclassical growth model fails to generate economic expansions in response to positive news about the future. Under a standard parameterization the growth model actually generates a recession today in response to positive news about future productivity (Figure 1). In recent years, this puzzling feature of the standard neoclassical model has generated many papers, all of which have aimed to modify or add features to the standard neoclassical growth model, so as to make it capable of generating expansions in response to positive news. These papers include the works of Beaudry & Portier (2004) who modify the standard growth model into a multi-sectoral durable/non-durable goods model. Christiano et. al. (2007) add habit formation
and investment adjustment costs to the standard neoclassical model in their simple model case, and additional nominal frictions in their full model case. Jaimovich & Rebelo (2008) add a special type of preferences, along with variable capital utilization and investment adjustment costs. Other papers in this literature include the early works of Beveridge (1909), Pigou (1927), and Clark (1934), and the more recent works of researchers such as Lorenzi (2005), Beaudry & Portier (2008), and Denhaan & Kaltenbrunner (2005). The main aim of the recent papers, along with others in this literature, has been to generate positive co-movements between output, consumption, investment, and labor hours, in response to positive news about the future. This paper adds to this growing literature by introducing a new channel in the neoclassical growth model, the dynamic demand curve channel, through which news about the future can affect economic decision making today, and thus cause an economic expansion.

The dynamic demand curves in this paper play an important role in explaining why positive news and expectations about the future lead to economic expansions today. When households exhibit deep habits (Ravn, Schmitt-Grohe, and Uribe (2006)), that is, when households form separate habits over each individual differentiated good, the demand curves faced by the producers of these differentiated goods is dynamic. The demand for any particular good now depends not only on current price, but also past consumption (habit) and future prices of that good. When such a demand structure exists in the economy, positive news about the future causes a firm to reduce its markups today in order to induce households to increase their stock of habit for the firm’s product. The increased stock of habit results in stronger demand for the firm’s product in the future, when productivity and demand are high, and costs are low. Intertemporally, the firms, in response to positive news about the future, are willing to forgo profits today by lowering markups, in return for a stronger habit for their goods, and thus much higher profits and markups in the future. Under such a pricing scheme, in response to positive news about future productivity, the lower markups of the firms generate increased consumption today and, with the addition of investment smoothing, also the need for increased investment. The only way to finance the increased consumption and investment in this economy today, in the absence of any productivity increase, is for the firms to increase labor demand. In this way, the dynamic demand curve channel in this paper results in increased consumption, investment, output, and labor hours, in response to positive news about the future. The dynamic demand curve channel also results in increased real wages and decreased markups.

This paper is most closely related to the work by Christiano et. al. (2007); however, its main innovation over that paper is that it matches a wider set of qualitative impulse responses, as compared to their simple model case. It also provides a more intuitive explanation, with firm groundings in anecdotal evidence from the 1990s, for why habits are important and how they don’t work directly, but through a demand curve channel. In addition to providing a more intuitive
explanation, the two other contributions of this paper to the literature are: First, in addition to the standard results, in response to positive news about the future, the model in this paper is able to generate positive movements in real wages and negative movements in markups. These two movements line up with the qualitative time series of real wage and marginal cost markups in the late 1990’s. The key here is that the dynamic demand curves provide a channel for wages today to be linked with future productivity - each additional unit of labor today not only increases output today, but generates a stream of future profits through the habit imbedded in the dynamic demand. Second, the dynamic demand curve in this paper is also able to generate sectoral co-movements in output, labor hours, and real wages between downstream sectors that are expecting an increase in productivity and upstream sectors that are not expecting an increase in productivity, the so called spillover effects.

The rest of this paper is organized as follows. Section 2 presents anecdotal evidence from the 1990’s to further strengthen its argument for the dynamic demand curve channel. Section 2 also looks at aggregate data from the 1990’s, to understand the qualitative response of the aggregate economic variables to positive news about the future. Section 3 presents a model with the dynamic demand curve feature. Section 4 discusses the corresponding results and section 5 concludes.

2 Motivating Evidence & Data

The strength of the dynamic demand curve channel lies in the ample anecdotal evidence available from the late 1990’s in support of it. One of the prevailing ideas in the 1990’s was that the best business model was to ‘Get Big Fast’\textsuperscript{1}. Old and new companies alike followed this business model, and in anticipation of future increases in demand and reduction in costs invested heavily in campaigns to lure more consumers to their products. Some of these campaigns were centered on advertising, while others were centered on discounts or lower prices. The common aim of both these campaigns was to subsidize consumers into forming a habit for the firm’s product.

Many companies spent heavily on advertising in the 1990’s in the hope of luring more customers to their products. A famous example is of pets.com, who spent over a million dollars in 2000 on Super Bowl advertisements, in the hope of drastically increasing their market share. Many other companies also followed a similar strategy, and paid millions for advertisement spots during the Super Bowl in 2000, and also during the late 1990’s in general. Similarly, there exist many examples of companies in the 1990’s that embarked on campaigns centered on discounts and lower prices. Famous examples for these kinds of campaigns come from industries as diverse as the grocery sector on one side, and the internet services providers sector on the other. In the grocery sector, Webvan, a start-up based out of California invested heavily in discount coupons in order to attract customers.

\textsuperscript{1}This was also the name of a book about amazon.com by Robert Spector (2000).
to their non-traditional grocery buying model - buying groceries online and having them delivered to one’s home. In the internet services providers sector, AOL invested heavily in mailing ‘100 free internet hour’ CD’s to millions of potential customers around the U.S. and the world. At its peak AOL had over 30 million subscribers across multiple continents. This paper argues that the main rationale behind these discounts and advertisements was to subsidize consumers into forming a habit for the firms product, and then to exploit this habit to generate higher profits when costs became low in the future. More formally, intemporally, in anticipation of lower costs and higher productivity, firms in the 1990’s were willing to lower markups in order to increase habits for their goods. By doing so, they hoped to extract a larger surplus from the consumers in the future when the costs were actually lower and productivity was high.

The dynamic demand curve channel posits that in response to positive expectations about the future, firms lower marginal cost markups. Aggregate data from the late 1990’s (Figure 2) shows that as indicators of future expectations, such as consumer sentiment and stock market indices increased, labor share of income also increased, and thus marginal cost markups decreased. In the absence of any true measure of marginal cost markups, the inverse of labor share gives a rough measure of marginal cost. More sophisticated measures of marginal cost markups, such as the one constructed by Banerjee & Russell (2005), using a methodology developed by Rotemberg & Woodford (1999), strengthen this observation further by showing a more protracted decreasing trend in marginal cost markups that extends as far back as 1993. Another interesting feature of the 1990’s data is that as the indicators of future expectations rose, real wages also continually showed an upward trend, an observation that is in sync with the results of the model. Finally, the 1990’s data also shows a continued upward trend in output, labor hours, consumption, and physical investment, observations that are in accordance with what is commonly believed to be the response of these variables to positive news about future productivity.

3 Model

The model economy of this paper is populated by three types of agents - households, upstream capital/intermediate/investment (henceforth CII) goods producing firms, and downstream consumption goods producing firms. As compared with the standard neoclassical framework, the economy also has two additional ingredients: First, it is populated with households that exhibit deep habits in a continuum of imperfectly substitutable consumption goods, in the spirit of Ravn, Schmitt-Grohe & Uribe (2006). This particular ingredient of the model economy results in the creation of the dynamic demand curves channel, which is key in explaining the model’s results. Second, the CII goods producing firms in this model economy own the investment goods and pay a Christiano, Eichenbaum, and Evans (2005)-type convex adjustment cost to change the flow of investment.
3.1 Households

A representative household in the model economy consumes a continuum of goods, \( c_{i,t} \), indexed by \( i \in [0, 1] \), and develops a ‘deep’ habit, \( s_{i,t} \), for each individual consumption good (this is in contrast to developing a habit for the aggregate consumption good, \( \int_0^1 c_{i,t} \, di \)). The consumption goods here are imperfectly substitutable, and thus, the households have a preference for variety as well. The price of each individual consumption good, \( c_{i,t} \), is \( p_{i,t} \).

In addition to demanding consumption goods the households also supply labor to the two sectors of the economy, \( n_{1,i,t} \) to each firm \( i \) in the consumption goods producing sector, and \( n_{2,t} \) to the CII goods producing sector. In return for the labor supplied to these two sectors, they receive compensation at a rate of \( w_{1,i,t} \) and \( w_{2,t} \) per unit labor hour respectively. The model differentiates between the two labor supply curves to study the effects of positive news on each sector individually.

The households period utility, which is discounted at a constant rate of \( \beta \), takes the following form:

\[
U = \left[ \frac{\left( \int_0^1 (c_{i,t} - \alpha_s s_{i,t-1}) \, di \right)^{1-\sigma}}{1-\sigma} \right]^{\frac{\theta}{\theta-1}} - \psi_1 \left( \int_0^1 n_{1,i,t} \, di \right)^{\gamma_1} - \psi_2 \frac{n_{2,t}^{\gamma_2}}{\gamma_2}
\]

where \( \alpha_s \) and \( \rho_s \) are habit parameters, \( \theta \) is the elasticity of substitution between varieties, \( \frac{1}{\sigma} \) is the elasticity of intertemporal substitution, \( \psi_1 \) and \( \psi_2 \) give the relative weights of the disutility of labor in the utility function, and \( \gamma_1 \) and \( \gamma_2 \) are the elasticities of labor supply for the two sectors, respectively.

The habit structure used above is referred to in the literature as internal deep habits. ‘Internal’ refers to the fact that the habits are household specific, and not economy specific (i.e. each household determines its own habit stock). ‘Deep’ refers to the fact that habits are unique for each good. This paper argues that this type of utility structure is prevalent in the economy; households do not only form habits that are unique to them, but they also form habits that are unique to each individual good they consume. This is in contrast to a formulation of aggregate habits, where habits are not unique to an individual good, but instead habits are formed over the total consumption bundle of all goods. There is also ample empirical evidence for the existence of these types of preferences: Bell et. al. (1999), Seetharaman et. al. (1999), and Browning & Collado (2007), among others, find evidence in the data that past purchases, past choices, or habits at the individual goods level, play a significant role in determining what goods households consume today. The identity of the firm plays an important role in the formation of habits, and the determination by households as to what good to buy, due to brand-loyalties and other transaction costs of switching to another firm. A consumer, who bought Colgate toothpaste yesterday, ceteris paribus, is more likely to buy
Colgate toothpaste today vs. Crest toothpaste.

The demand curve generated by internal deep habits takes the following form:

\[ c_{i,t} = E_t \left[ \lambda_t p_{i,t} + \sum_{k=0}^{\infty} \left( \beta \left( (1 - \rho_s) + \rho_s \alpha_s \right) \right)^{\lambda_{t+1} + k} p_{i,t+1+k} \right]^{-\theta} A_t^\theta + \alpha_s s_{i,t-1} \]  

where \( A_t \) here contains aggregate non-firm specific variables.

This demand curve, simplified, can be written as:

\[ c_{i,t} = f(c_{i,t-1}, c_{i,t-2}, c_{i,t-3}, ...) + E_t g(\lambda_t p_{i,t}, \lambda_{t+1} p_{i,t+1}, \lambda_{t+2} p_{i,t+2}, ...) \]

This demand curve is dynamic - demand depends not only on current price, but: 1) it also depends on past consumption(habit); and 2) it also depends on the expectations of a future stream of prices. The first of these ensures that as habit for a particular good increases, current demand for that good also increases. Put another way, if the price today decreases, not only does habit for that good increase, but demand for that good in the future also increases. Firms in such a setting have incentive to decrease price today, especially if they are expecting a future productivity shock, as the increased habit that results allows them to extract greater profits in the future when productivity is high and costs are low. The second of the two dynamic features - that demand today depends not only past variables but also negatively on expectations of future prices, dampens, but does not eliminate, the effectiveness of the firm’s decreasing price today and increasing profits in the future strategy. This feature, however, under a standard calibration, allows for a forward looking component in the firms’ decision making, allowing wages today to be connected with future marginal productivity of labor. In summary, the internal deep habits formulation of utility in the model gives firms an incentive to lower markups today in order to generate increased habit, and it also provides a forward looking component to wage determination.

3.2 Firm: Consumption Sector

A typical firm \( i \) in this sector of the model economy hires labor, \( n_{1,i,t} \), at wage \( w_{1,i,t} \), and rents capital (buys intermediate goods), \( k_{1,i,t} \), at a rent rental rate of \( r_t \). It combines these two inputs using a standard Cobb-Douglas production technology, to produce differentiated consumption goods. The production function it uses in this process takes the following form:

\[ f(k_{1,i,t}, n_{1,i,t}) = a_t k_{1,i,t}^{1-a_1} n_{1,i,t}^{a_1} \]  

where, \( a_t \) is a non-firm specific sector wide technology parameter.
Also, due to the limited substitutability of their products, firms in this sector have monopolistic power, and can thus exploit the dynamic demand curve given by equation 2. Profit maximization by these firms, taking the dynamic demand curve into account, generates the following pricing rule - the equation which determines how the firms will price their goods:

$$p_{i,t} = \frac{\theta}{\theta - 1} \mu_{i,t} + E_t h(\ldots, \mu_{i,t-2}, \mu_{i,t-1}, \mu_{i,t}, \mu_{i,t+1}, \mu_{i,t+2}, \ldots; \text{parameters})$$

where \(\mu_{i,t}\) is the marginal cost, and \(h(\bullet; \alpha_s = 0) = h(\bullet; \theta = \infty) = 0\). \(^2\)

The pricing rule above shows that the firm’s markup over marginal cost has two components, and thus the firms have two distinct ways to exploit monopoly power. The first component, \(\frac{\theta}{\theta - 1}\), is constant over time and comes from the assumption of limited substitutability between the goods. The second component, \(\frac{h(\bullet)}{\mu_{i,t}}\), varies over time, and results from the dynamic nature of the demand curve. That is, firms can exploit the habit stock accumulated by the households for their good. This second component is important for the results in this paper, via the consumer’s habit imbedded in it, it provides the firms incentive to lower their markups today in response to news about the future. Lower markups today lead to stronger habits in the future, and thus higher markups and profits for the firm in the future, when the marginal costs are relatively low due to high productivity. Also, these lower markups along with the consumption smoothing motive in the household’s utility cause consumption in the model economy to increase in response to positive news about future productivity.

The dynamic component in the above pricing rule also provides a link between wage today and future productivity. Because labor markets are perfectly competitive in this model, the wage is equal to the marginal revenue product of labor. However, one can see from the above rule, that the revenue from each additional unit of labor is not only dependent on marginal cost today but also on future marginal costs, and thus future marginal productivity. Each unit of the good sold today, generates a stream of future profits through its effect on the habit variable. As a result, when future productivity is expected to be high, the current expected revenue stream from each unit produced rises, and thus the current marginal revenue product of labor which equals the wage also rises. In this way expectations about high future productivity in the market, result in higher wages today, and all else equal, also result in a higher supply of labor. This feature of the model that real wages increase in response to positive news, a feature seen in the late 1990’s data, is very hard to generate with most standard models. If TFP does not increase today but labor hours do increase, then generally the marginal revenue product of labor will decrease, and thus wage will also decrease. In this paper, as explained above, the addition of the dynamic demand curve channel

\(^2\)The derivatives of \(h(\bullet)\) with respect to \(\mu_{i,t+j}\), and the parameters, \(\alpha_s\) and \(\rho_s\), are complicated and the signs are not statically clear.
is key in helping the model overcome this problem, and qualitatively match the late 1990’s data.

The paper makes two key implicit assumptions in deriving the above pricing equation. The first is that firms can commit to a pricing policy. The demand curve faced by the firms above is dynamic, in particular it depends on future prices, and as a result the firms’ maximization problem results in a dynamically inconsistent solution\(^3\). Assuming commitment here solves this technical problem without affecting the validity of the eventual results. The final results, under commitment, already show the firm extracting surplus from the households in the future.

The second implicit assumption here is that the firms are owned by risk neutral entrepreneurs. Firms only discount their profits by the constant \(\beta\). The main reason for having this assumption is that if firms discount profits by a stochastic discount factor, based on the households’ marginal utility, then in an attempt to smooth the households’ consumption stream, the firms give up their intertemporal pricing power. Thus, the firms only charge a markup that arises from the monopoly power afforded to them by the limited substitutability of their goods, and the second component of the pricing equation drops out. The pricing rule then reduces to the basic Dixit-Stiglitz (1977) constant elasticity case of \(p_{i,t} = \frac{\theta}{\theta - 1} \mu_{i,t}\). In order to maintain the dynamic demand curve channel in the model, the paper thus assumes risk neutral entrepreneurs \(^4\).

### 3.3 Firm: Capital/Intermediate/Investment (CII) Goods Producing Sector

A representative firm in this sector of the model economy produces investment goods, \(i_t\), and capital/intermediate goods, \(k_{1,t}\), by hiring labor, \(n_{2,t}\), and combining it with the capital stock, \(k_{2,t}\), that it owns. The firm rents the capital/intermediate goods it produces to the consumption goods producing firms, and retains the investment goods to replenish its personal stock of capital. The returned depreciated capital/intermediate goods are also used to replenish the firm’s capital stock for the next period. The representative firm thus maximizes its profits subject to a production constraint and a law of motion for its capital stock\(^5\):

\[
k_{1,t} + i_t = k_{2,t}^{1-\alpha_2} n_{2,t}^{\alpha_2}
\]

\(^3\)As indicated by Ravn, Schmitt-Grohe & Ravn (2006), and confirmed in detail by Nakamura & Steinsson (2007).

\(^4\)Back-of-the-envelope calculations show that this assumption can be relaxed to just having entrepreneurs that have a smaller curvature in utility than the households.

Note: These assumptions are consistent with the notion that in an economy with heterogeneous agents, all else equal, agents that are less risk averse will become entrepreneurs

\(^5\)Period profits here are again discounted by the constant \(\beta\). Discounting this firm’s profits by a stochastic discount factor doesn’t affect the results. However, for the sake of consistency and comparability between the two different sectors, the paper chooses to assume a constant discount factor.
\[ k_{2,t+1} = \hat{i}_t + (1 - \delta_2) k_{2,t} - \kappa \left( \frac{i_t}{i_{t-1}} \right) i_t \]

\[ \hat{i}_t = i_t + (1 - \delta_1) k_{1,t} \]

As indicated in the law of motion for capital (Equation 6), the firms in this sector also face a convex investment adjustment cost as used in Christiano, Eichenbaum, and Evans (2005). As the economy-wide output rises in the model, the strong consumption smoothing motive, coming from the dynamic demand curve, causes consumption to rise rapidly, which in turn causes investment to rapidly fall. The inclusion of the convex investment adjustment cost ensures that the consumption smoothing motive doesn’t overpower the investment, and drastically reduce its share of output. This particular formulation of investment adjustment costs, as shown by Lucca (2006), is equivalent to a ‘time-to-build’ story in the spirit of Kydland and Prescott (1982). Thus, it lends itself to the intuition, that its inclusion forces firms in this model to start accumulating investment early in response to positive news about the future, as investment takes time to become productive, and this counterbalances the effect of rapid consumption increases.

### 3.4 Structure Of News Shocks

The shock to future productivity, news shock, takes the following specification introduced by Christiano et. al. (2007):

\[ \ln(a_t) = \rho_a \ln(a_{t-1}) + \tilde{\epsilon}_{t-p} - \epsilon_t \]

where \( \tilde{\epsilon}_t \) represents a news shock and \( \epsilon_t \) a contemporaneous shock. Under this specification, in period 1 agents in this model economy get news that productivity will change after \( p \) periods. However, depending on the value of \( \epsilon_{p+1} \), this news may or may not turn out to be true in period \( p + 1 \), the period of the expected change in productivity. In the benchmark case \( \tilde{\epsilon}_{t-p} = \epsilon_t \), that is, the news turns out to be completely false (The news is not realized). If \( \epsilon_t = 0 \), then the news is completely true (The news is realized). Figure 3 shows the impulse responses for these two extreme cases, when \( p \) is set to 4.

### 4 Results & Discussion

This section of the paper presents the calibration, and the impulse responses of the model economy to news shocks. It also includes a discussion of the results, along with tests of their robustness.

#### 4.1 Calibration

The model is calibrated to standard values found in the literature for when one model economy period is equal to one quarter. The parameter values are as follows:
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha_i$</td>
<td>$2/3$</td>
<td>Labor Share in Production</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.99</td>
<td>Subjective Discount Factor</td>
</tr>
<tr>
<td>$\delta_1$</td>
<td>0.025</td>
<td>Depreciation Rate of Capital/Intermediate Goods</td>
</tr>
<tr>
<td>$\delta_2$</td>
<td>0.025</td>
<td>Depreciation Rate of Capital</td>
</tr>
<tr>
<td>$\gamma_i$</td>
<td>2</td>
<td>Elasticity of Labor Supply</td>
</tr>
<tr>
<td>$\psi_i$</td>
<td>1</td>
<td>Weight of Disutility from Supplying Labor</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>0.8</td>
<td>Inverse of the Intertemporal Elasticity of Substitution</td>
</tr>
<tr>
<td>$\theta$</td>
<td>4</td>
<td>Elasticity of Substitution between Different Variety of Goods</td>
</tr>
<tr>
<td>$\alpha_s$</td>
<td>0.5</td>
<td>Habit Formation Parameter in Utility</td>
</tr>
<tr>
<td>$\rho_s$</td>
<td>0.5</td>
<td>Habit Formation Parameter in Habit Accumulation Equation</td>
</tr>
<tr>
<td>$\kappa(\bullet)$</td>
<td>1.5</td>
<td>Investment Adjustment Cost Parameter</td>
</tr>
<tr>
<td>$\rho_a$</td>
<td>0.99</td>
<td>Persistence of the Productivity Shock</td>
</tr>
<tr>
<td>$p$</td>
<td>4</td>
<td>Periods to Actual TFP Increase</td>
</tr>
</tbody>
</table>

The value of $\sigma$ is slightly lower at 0.8 than the usual 1, however, it is well within the ranges of empirical estimates in the literature (Beaudry & Wincoop (1996), Vissing-Jørgensen & Attanasio (2003) and Mulligan (2002)). The choice of $\sigma$ less than 1 is to generate a slightly weak wealth effect in the model. The value of $\rho_a$ is chosen to be 0.99 to generate a highly persistent shock, a shock just short of being permanent. And finally, $p$ is chosen to be equal 4, that is the news is about TFP four quarters into the future, that is, one year into the future.

### 4.2 Results

Assuming a symmetric equilibrium, Dynare is used to the generate impulse responses for the model economy, using the above calibration. The results for this baseline model economy are given in Figure 4. In period 1, agents in this economy get news of a 1% increase in TFP, $a_t$, that will take place in four periods (period 5). In response to this news shock, output, consumption, investment, and labor hours all rise until period 5. Real wage on getting the news in period 1 falls a little below steady state, however, then trends upward (staying above steady state as well) until period 5. In the case where the news turns out to be true, these variables, with the exception of labor hours, continue to rise, while in the case where it turns out to be false they all immediately fall. When the news turns out to be false the impulse responses are qualitatively very similar to the historical data series from the late 1990's (Figure 2). In the late 1990's output, consumption, investment, labor hours and real wages all rose significantly, and at the beginning of the new millennium they all witnessed significant drops. The impulse responses also show a decrease in markups, and a corresponding decrease in profits, in both the cases of when the news is realized and the news is not realized. However, in the case when the news is realized the firms are able to extract a larger surplus, after period 4, from the consumers than in the case when it is not realized. The case when the news is not realized is again very similar to the historical data series of markup, as given by the inverse of labor share in income.
The rapid fall in labor hours, even after the news is true, can be attributed to the lingering wealth effect, due to habit formation, in the model. Christiano et al. (2007) experience a similar drop in labor hours in their model. They claim that the main reason for this fall is the absence of any labor market frictions in their model, and that the addition of these frictions would mitigate this drop without affecting the main results. This paper agrees with this argument, and also posits that the addition of labor market frictions would mitigate this drop without changing the main results, but would unnecessarily complicate the model.

The two bottom left panels in Figure 4 give the sector-wise breakup of wages. Real wages in the consumption sector rise directly due to the effect of the dynamic demand curve channel - current revenue is linked to future productivity. However, real wages in the investment sector rise indirectly due to the effect of the dynamic demand curve channel. In this latter case, future productivity affects the marginal revenue product of the capital/intermediate goods in the consumption sector, thereby linking the revenue generated by each additional capital/intermediate good today to future productivity. This in turn links the marginal return on labor in the CII goods sector, through the capital/intermediate goods, to future productivity in the consumption sector, and thus causes real wages in this sector to increase in response to news shocks. This is the so called “spill-over” effect of the future productivity shock, from the downstream consumption sector, that is expecting the shock, to the upstream CII goods sector, that is not expecting any shock. Finally, Figure 5 also gives the sector-wise breakup of labor hours and output. Similar to their aggregate counterparts, labor hours and output rise in the first 4 periods in response to positive news about the future, again due to the spill-over effects.

4.3 Discussion

Internal deep habits and the resulting dynamic demand curves are central to understanding why expectations of future productivity result in increases in output, consumption, investment, labor hours, and real wages today. To dissect this further, figure 6 gives the impulse responses of the model economy when there are no internal deep habits ($\alpha_s = 0$), and also when there are habits, but in the aggregate goods instead of the individual goods. In the aggregate good case the period utility takes the following form:

$$U = \left[ \left( \int_0^1 c_{i,t}^{\frac{1}{\theta}} di \right)^{\frac{\theta}{\theta-1}} - \alpha_s s_{i,t-1} \right]^{1-\sigma} - \psi_1 \left( \int_0^1 n_{1,i,t} di \right)^{\gamma_1} - \psi_2 n_{2,t}^{\gamma_2}$$

$$s_{i,t} = \rho_s \left( \int_0^1 c_{i,t}^{\frac{1}{\theta}} di \right)^{\frac{\theta}{\theta-1}} + (1 - \rho_s) s_{i,t-1}$$
In the case where there are no habits at all, consumption falls, as there is no consumption smoothing motive. Also, in the absence of internal deep habits there is no link between future productivity and wage today, which causes real wages in the consumption sector to fall. The pricing rule also reduces to $p_{i,t} = \frac{\theta}{\theta - 1} \mu_{i,t}$; that is, markups remain constant. On the other hand, in the case of aggregate habits, consumption does increase via the consumption smoothing motive, however, again in the absence of a channel between today and productivity tomorrow, wages fall in the consumption sector. Only with the addition of internal deep habits is there a channel for wages to be linked with future productivity, and thus for wages to increase today in response to positive news about the future. The inclusion of internal deep habits, also further strengthens the increase in consumption, as the firms now lower markups in response to positive news.

Investment adjustment costs are a supporting ingredient in this model. Figure 7 shows the impulse responses for the main aggregate variables when investment adjustment costs are not present ($\kappa(\bullet)^{\prime\prime} = 0$). The main qualitative difference in this case is that investment falls in response to a news shock, as a large portion of the output that was previously used for investment now goes towards smoothing the consumption stream. The addition of investment adjustment costs provides a counterbalance to this strong consumption smoothing effect of internal deep habits, allowing a fair share of the output to also go towards investment.

### 4.3.1 Robustness

The inclusion of an upstream and a downstream firm in the model economy helps capture the inner working of the economy, helping mainly to explain how positive news shock spillovers occur. However, it is important to make sure that this separation of firms alone isn’t driving the results of the model. Figure 7 shows the impulse responses for the case where there are no investment adjustment costs or internal deep habits, just a structure of the economy, in which downstream and upstream firms are separated. Output and consumption both decrease in response to a news shock in this case, and consumption continues to fall until the period of the actual increase in TFP. Thus, it can be concluded that internal deep habits and investment adjustment costs play an important role in the baseline model economy.

An important result of this paper is that it is able to generate spillovers from a downstream sector experiencing a news shock to an upstream sector not experiencing a news shock. The real wages in both sectors of the economy move in sync with each other due to this spillover. As seen in Figure 7 changing $\delta_1$ from 0.025, the depreciating capital case, to 1, the intermediate good case, keeps this result intact. Thus, this channel is robust to the depreciation of the good that flows between these two sectors.

As a next robustness check this paper also examines different types of news shock structures. It
can be argued that the news shock experienced by the economy in the late 1990’s did not take the form used in this paper. One may argue that the news shock had both a news component and a contemporaneous component to it. Figure 8 shows the case where the economy in period 1 experiences both a small positive contemporaneous shock to TFP, $a_t$, of 0.1%, and the news shock of this paper. The impulse responses of such a hybrid shock qualitatively look the same as the impulse responses for just the news shock case, indicating robustness of the model to hybrid shocks.

Finally, the most interesting outcome of news shocks in the literature, and also described by this model, is that beliefs, more than actual TFP changes, are the drivers of business cycles. Figure 8 shows two of the classical cases of this outcome, one of over-pessimism and the other of over-optimism. In the case of over-optimism; $\tilde{\epsilon}_1 = 1$ and $\epsilon_5 = 0.9$ in equation 7, that is in period one the economy believes a 1% increase in TFP will occur in period 5, but when period 5 arrives only a 0.1% increase in TFP materializes. Here, even though TFP increases in period 5, the economy experiences a drop in output, as the news and not the TFP was the main driver of the business cycle. In the case of over-pessimism; $\tilde{\epsilon}_1 = -1$ and $\epsilon_5 = -0.9$ in equation 7, that is in period one the economy believes a 1% decrease in TFP will occur in period 5, but when period 5 arrives only a 0.1% decrease in TFP occurs. Here, even though TFP decreases in period 5 the economy experiences an expansion this period, again this is because news and not TFP in this model is the main driver of the business cycle.

5 Conclusion

Events such as the late 1990’s have illuminated the role of news and expectations in the formation of business cycle fluctuations. Unfortunately, though, the main building block of modern day economics, the neoclassical growth model, is unable to account for this phenomenon. The neoclassical growth model predicts a recession in response to positive news about future productivity. This paper has shown how the dynamic demand curve channel, via the addition of internal deep habits, can help the neoclassical growth model account for the role of news and expectations in business cycle formation. This modified model is also able to qualitatively match the responses of many key economic variables including output, consumption, investment, labor hours, real wages, and markups to the aggregate data of the late 1990’s. Most importantly, it is able to do this using an intuitive forward looking explanation centered around dynamic demand curves, a construct that has firm groundings in anecdotal evidence from the late 1990’s.
References


Figure 1: News Shock Impulse Response: Standard Neoclassical Growth Model - News Shock when the News is Not Realized
Figure 2: Historical Aggregate Data from the 1990’s - Source: BEA
Figure 3: News Shock Impulse Response: Technology
Figure 4: News Shock Impulse Response: Baseline Model
Figure 5: News Shock Impulse Response: Baseline Model - Sector-wise Breakup
Figure 6: News Shock Impulse Response: Model with No Habit & Model with Aggregate Habit
Figure 7: News Shock Impulse Response: Baseline Model - Modifications to Ingredients
Figure 8: News Shock Impulse Response: Baseline Model - Modifications to News Shock Structure