

## Part B New Keynesian Economics

There are several different new Keynesian models presented in this chapter. Rather than going into each model in detail (there are several covered in Part C of the text), this reading guide will discuss new Keynesian models in a general sense. For the most part, these models were developed in response to the new Classical approach. In the end, we will arrive at the same basic conclusion that there is a positive relationship between output and inflation (in the short-run), but the reasons why are fundamentally different in these two approaches. So, while the new Classical model generates a positive relationship between output and inflation (on the supply-side resulting from imperfect information), this approach leads to the policy ineffectiveness proposition:

Policy ineffectiveness proposition: Only unanticipated changes in monetary policy affect real economic variables. Furthermore, because agents have rational expectations, any systematic policy actions will lead to a response by households and firms that offset the potential real effects of said policy actions.

That is, the parameter in the IA curve that measures the correlation between inflation and output changes.<sup>4</sup> Lucas (1973) demonstrates this empirically for a select group of countries. In contrast, the implications of the new Keynesian models are inconsistent with this proposition.<sup>5</sup>

The implications of the new Classical approach remain important in modern macroeconomics. First, this approach generates a set of linear equations that is essentially the same as what one would see in a Keynesian-type model, despite making fundamentally different assumptions about how the macroeconomy works. Second, the model is based on microfoundations (household/firm utility/profit maximization) AND retains one of the key assumptions of the classical model: perfect competition. Third, the model explicitly integrates expectations into utility/profit maximization decisions. This third contribution is now a standard feature of macroeconomic models: in both the RBC and new Keynesian approaches.

Essentially, the new Classical approach challenges Keynesians to develop a model in which sticky prices/wages are the result of rational behavior. As we will see, the new Keynesian approach retains many of the same implications as the traditional approach, but the modeling approach is very different from the

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<sup>4</sup>The Lucas (1976) econometric critique is related to this idea - one cannot use an estimated model of the macroeconomy (e.g., a coefficient estimates for the parameters in the IS/MP/IA model) to study how policy changes affect the economy because the parameters themselves change when policy is anticipated.

<sup>5</sup>There is a small subset of New Keynesian models that use state-dependent pricing in order to generate situations where monetary policy does not affect real output. One example is presented in part C of Romer: the Caplin-Spulber model, based on Caplin and Spulber (1987). We will largely ignore these models discussing the implications of the New Keynesian model. These implications are not robust and the assumptions are not applicable to the broad class of New Keynesian models.

traditional Keynesian approach that did not build models from utility/profit maximizing behavior.

## **6.4 New Keynesian Approach: Imperfect Competition and Price-Setting**

### **6.4.1 What is a “new Keynesian” model?**

Before tackling the new Keynesian approach in detail, it is worth noting a few key questions about this class of models. First, what makes a model “Keynesian”? Second, what differentiates these models from their traditional predecessors?

New Keynesians are Keynesian in that they believe that wage and price stickiness are important features of the economy, and that this implies a positive role for countercyclical policy. By in large, they maintain the position that stabilization policy can improve economic outcomes. This is in direct contrast to the new Classical approach policy ineffectiveness proposition. According to the new Classical, policy is fundamentally destabilizing - deviations in aggregate demand lead to producers having to extract signals from their individual prices. The more policy intervenes, the noisier the signal, and the less effective is policy in terms of its effect on real output.

New Keynesians differ from “old Keynesians” in that rather than simply asserting that prices or wages are sticky, they seek a microeconomic framework in which the maximizing decisions of rational agents lead to stickiness. This is the key feature that is retained from the new Classical approach. It’s importance cannot be overstated: why would firms and households enter into contracts that would reduce their welfare? This is a question new Keynesian models, such as the simple model proposed by Mankiw (1985), must address.

The hallmarks of new Keynesian models are the following: imperfect competition in either the labor market or goods market, and costs associated with changing wages/prices in these markets. These assumptions are necessary for the existence of sticky wages/prices.

### **6.4.2 The importance of market structure and imperfect competition**

Imperfect price adjustment cannot occur in a world of perfect competition. Why? Perfectly competitive firms cannot set their prices. If the products of all firms are perfect substitutes, as in a perfectly competitive market, then any firm that sets its price above its competitors will see its sales go to zero. In this case, an individual firm cannot afford to have any (downward) price rigidity at all - it would not be profit maximizing. In this sense, the perfectly competitive firm takes the price as given by the market.

This is why new Keynesian models have incorporated imperfect competition as the fundamental market structure. The market model that is usually cho-

sen in new Keynesian models is a simple version of monopolistic competition. Monopolistic competition exists when there are many sellers of a differentiated product in a market with low barriers to entry. The absence of barriers to entry implies that there should be zero profits in the long run. Product differentiation implies that one firm's product is not a perfect substitute for the goods produced by others. Therefore, the individual firm faces a downward-sloping demand curves. They choose individual prices in order to maximize profits.

In order to understand fluctuations in aggregate output we must look specifically at the price-setting behavior of each firm. This is what makes new Keynesian models mathematically complicated. It is worth noting that the classical, RBC, new Classical, and new Keynesian models all assume exactly the same aggregate demand structure for the economy. Where they differ is in their assumptions about price adjustment on the supply side, or the IA curve in the IS/MP/IA model.

### 6.4.3 Basic Model with No Nominal Rigidities

Begin with the model presented in part A of Romer. First, Romer eliminates the idiosyncratic shocks from the model. Since we are focused on studying aggregate variables, these shocks are not essential for our analysis. While their presence is important (for the signal extraction problem), they are less critical in the model presented below.

Starting with a model where prices adjust perfectly allows us to consider the implications that imperfect competition have for real output. Later, we will consider how nominal rigidities (sticky prices/wages) will affect our analysis.

#### Assumptions

Demand for an individual good is log-linear:

$$q_i = y - \eta(p_i - p)$$

where  $q_i$  is the demand for the individual good  $i$ ,  $p_i$  is the price of this good, and  $p$  is an aggregate price (equal to the average of the individual prices). In levels, this expression is:

$$Q_i = Y \left( \frac{P_i}{P} \right)^{-\eta}$$

The next assumption is a key departure from the Lucas model from part A. The goods market is characterized by imperfect competition. The individual producers are monopolist competitors, each producing an differentiated product. As monopolist competitors, they are price setters. In the Lucas model, the producer was a perfect competitor, only able to adjust its production in response to market conditions. Here, the producers choose their prices to maximize profit, relative to overall prices in the economy. Moreover, since the producers are monopolist competitors, they first choose their profit maximizing price, then

the quantity produced is dictated by the demand curve for their individual product.

This market structure tells us something about the parameter  $\eta$  in the new Keynesian model. In the Lucas model, this parameter  $\eta$  is a function of the signal extraction problem faced by firms (we called it  $\alpha\beta$  in that model). Here,  $\eta$  affects the markup charged in the individual monopolistic competitor. We assume  $\eta > 1$ , so that the individual firm charges a markup above the aggregate price (which we can show is equal to the marginal cost). Once we solve for output, we will see that  $\eta > 1$  is necessary in order for there to be some positive level of output in this economy. Below, we will show that the markup is actually equal to  $\frac{\eta}{\eta-1}$ .

The production function is the same as in Lucas:

$$Q_i = L_i$$

Note that because we are dealing with monopolist competitors, there is room for the firms to earn profit. Profit  $\Pi$  for monopolist competitor  $i$  is:

$$\Pi = P_i Q_i - W L_i = (P_i - W) Q_i$$

The labor market is perfectly competitive, so the wages are not indexed by the firm. These profits are paid to the household which owns this firm. Therefore, the household earns income equal to profit plus wages earned =  $(P_i - W) Q_i + W L_i$ .

The utility function is the same as the one used in the Lucas model. The household's utility function is defined as:

$$U_i = C_i - \frac{1}{\gamma} L_i^\gamma$$

Note that since  $C_i$  is real consumption and there is no investment, government spending, or net exports in this economy,  $C_i = \frac{P_i Q_i}{P}$ . Now the household earns profits from the firm. The household can use this profit to purchase consumption goods. We can add  $W L_i$  and subtract  $W Q_i$  (since  $Q_i = L_i$ ) to the numerator to obtain the following utility function (equation 6.37 from Romer):

$$U_i = \frac{(P_i - W) Q_i + W L_i}{P} - \frac{1}{\gamma} L_i^\gamma$$

Aggregate demand is given by the expression:

$$y = m - p$$

In levels, this expression is

$$Y = \frac{M}{P}$$

### Individual Behavior

The household chooses two variables: the price of his/her differentiated product,  $P_i$ , and work hours,  $L_i$ . Substituting in the demand curve for the individual product  $Q_i = Q_i = Y \left(\frac{P_i}{P}\right)^{-\eta}$ , we have:

$$U_i = \frac{(P_i - W)Y \left(\frac{P_i}{P}\right)^{-\eta} + WL_i}{P} - \frac{1}{\gamma}L_i^\gamma$$

This substitution incorporates the “budget” constraints.

Maximizing utility with respect to  $P_i$  yields:

$$\frac{\partial U_i}{\partial P_i} = 0 : \frac{Y \left(\frac{P_i}{P}\right)^{-\eta} + (P_i - W)Y \left(\frac{P_i}{P}\right)^{-\eta-1} (-\eta) \left(\frac{1}{P}\right)}{P} = 0$$

Rewriting this expression:

$$\frac{Y \left(\frac{P_i}{P}\right)^{-\eta}}{P} = \frac{(P_i - W)Y \left(\frac{P_i}{P}\right)^{-\eta-1} (\eta) \left(\frac{1}{P}\right)}{P}$$

Cancelling like terms:

$$\begin{aligned} 1 &= (P_i - W)\eta \left(\frac{1}{P}\right) \left(\frac{P_i}{P}\right)^{-1} \\ \left(\frac{P_i}{P}\right) &= \eta \frac{(P_i - W)}{P} \\ \left(\frac{P_i}{P}\right)(1 - \eta) &= -\eta \frac{W}{P} \\ \frac{P_i}{P} &= \frac{\eta}{\eta - 1} \frac{W}{P} \end{aligned}$$

This is identical to Romer’s equation 6.40.

Maximizing utility with respect to labor yields:

$$\frac{\partial U_i}{\partial L_i} = 0 : \frac{W}{P} - L_i^{\gamma-1} = 0$$

Rewriting yields Romer’s equation 6.5:

$$L_i = \left(\frac{W}{P}\right)^{\frac{1}{\gamma-1}}$$

This is the labor supply curve for households, with elasticity equal to  $1/\gamma - 1$  (as in the Lucas model).

## Equilibrium

To solve for equilibrium aggregate supply, we have to assume that the households and producers are identical.

At equilibrium, each household works the same amount,  $L_i = L$ . Therefore,  $Q_i = Y = L$ . Making this substitution into the labor supply equation above yields:

$$\frac{W}{P} = Y^{\gamma-1}$$

We can substitute this solution for the real wage into the first order condition for  $P_i$ :

$$\frac{P_i^*}{P} = \frac{\eta}{\eta-1} Y^{\gamma-1}$$

where  $P_i^*$  is the equilibrium price of product  $i$ . In logs (lower case letters denote logs):

$$p_i^* - p = \ln \frac{\eta}{\eta-1} + (\gamma-1)y$$

Note, this expression is similar to the Lucas supply curve. It expresses output as a function of the difference between individual prices and (expected) aggregate price.

If the households are identical, then the individual prices will be identical (since the households own the firms),  $P_i^* = P$ :

$$\begin{aligned} 1 &= \frac{\eta}{\eta-1} Y^{\gamma-1} \\ Y &= \left( \frac{\eta}{\eta-1} \right)^{\frac{1}{\gamma-1}} \end{aligned}$$

We can see from this expression that  $\eta > 1$  in order to generate a positive level of output. The aggregate price level is obtained from the aggregate demand equation:

$$Y = \frac{M}{P}$$

Solving for  $P$  and substituting in for  $Y$ :

$$P = \frac{M}{\left( \frac{\eta}{\eta-1} \right)^{\frac{1}{\gamma-1}}}$$

## Implications

In the new Classical model, output deviates from its potential, or optimal value,  $\bar{Y}$ , because the individual producers are tricked into producing more/less when they see their individual prices change. In the new Keynesian model, the firms generally produce less than what is optimal because of the deadweight losses associated with imperfect competition. This is important because it means the economy produces less than the socially optimal amount, even in the long

run. This is a significant departure from the new Classical, classical, and RBC models.

This implication is critical to the new Keynesian argument in favor of stabilization policy. Because output is always less than socially optimal, the effects of shocks are asymmetric. A positive shock brings the economy closer to optimal, and therefore may not warrant a policy response. A negative shock, on the other hand, drives output further from optimal, so policy should intervene to offset recessions. In the new Classical model, the argument against stabilization policy relies on the economy returning to a long-run output level that is optimal.

How does this implication of long-run inefficiency depend on the model's parameters? The critical parameters here are  $\eta$ , the size of the markup, and  $\gamma$ , which determines elasticity of labor supply. In the model presented in Romer, the optimal level of output is 1. To see how these parameters affect the level of output:

$$Y = \left( \frac{\eta}{\eta - 1} \right)^{\frac{1}{\gamma - 1}}$$

Since  $\eta > 1$ ,  $Y < 1$ . As  $\eta \rightarrow 1$ , the  $Y$  decreases, e.g., moves further from the optimal level. We can see from this expression that as  $\gamma \rightarrow 0$ ,  $Y \downarrow$ .

Notice that from the expression from the real wage, a decrease in output implies an increase in the nominal wage:

$$\frac{W}{P} = Y^{\gamma - 1}$$

If output decreases, we can see from the above expression that the real wage will increase. This implies that wages are countercyclical. Recall, from the data, we know there is a very small negative correlation between real wages and cyclical output. The new Keynesian model implies a negative relationship between output and real wages. While this is an improvement on the strong positive relationship found in the RBC model, an ideal model would generate no correlation between the two variables.

Finally, this model alone is not enough to generate a positive relationship between inflation (prices in this case) and output in aggregate. We can see from the expression for the aggregate price level,  $P$ , that for a given shock to aggregate demand (suppose  $M$  decreases by some amount  $x$ ), the price level will change proportionately with the change in  $M$ , so that  $\frac{M}{P}$  is unchanged, leaving real output  $Y$  unaffected.

Consider how the implication of non-optimality *would* affect the economy when shocks to aggregate demand do not have proportionate effects on aggregate prices. While this is not the case in the model above, we can still use the model to see how this would affect decisions. Specifically, suppose that there is a negative aggregate demand shock such that  $\frac{M}{P} \downarrow$ . From the aggregate demand equation, this means output decreases. But why? The mechanism in this model is fundamentally different from the previous models we've seen.

First, when output declines, the household's wages decrease (remember wages are countercyclical), so the household's work hours supplied will decrease.

This is identical to the new Classical and RBC models and has no effect on the household's net utility (he forgoes wages but enjoys more leisure). Second, the household/firm's individual demand curve for its product shifts to the left. Since the household/firm is selling at a price that exceeds its marginal cost, this does affect its utility. This is known as an aggregate demand externality - when aggregate shocks affect individual utility. Again, this is a direct result of the assumption of imperfect competition. These externalities will be important later on because they allow for a situation where the household/firm will not change its price, if the *net* effect on its utility/profit don't make it worthwhile to do so.

The model above gives us a simple linear equation for price setting behavior:

$$p_i^* - p = \ln \frac{\eta}{\eta - 1} + (\gamma - 1)y$$

Simplify this expression as:

$$p_i^* - p = c + \phi y$$

where  $\phi = (\gamma - 1)$ . Here, we can see that if  $\phi > 0$  the relative price level is an increasing function of output (as we saw in the Lucas model).<sup>6</sup> We can express the prices in terms of aggregate demand shocks by substituting the aggregate demand curve into the supply curve above:

$$p_i^* = c + (1 - \phi)p + \phi m$$

## 6.5 New Keynesian Approach: Are Small Frictions Enough?

### 6.5.1 General Considerations.

When we incorporate nominal rigidities into the model above, it is possible for aggregate demand to affect output. This happens because the aggregate demand externalities mean that when there is an aggregate demand shock, it is possible that the firm's gain in profit associated with adjusting its price is small. As long as this gain is smaller than the menu costs associated with changing the price, the firm will keep its price fixed. Therefore, even if there is a big reduction in aggregate demand, the firm's incentive to change its price could be small. This point is illustrated more clearly and explicitly in Mankiw (1985).

Having said that, the primary limitation of the model is as follows. In order to generate fluctuations in output that are consistent with the cyclical fluctuations observed in the data, we would need to assume that menu costs are very large. Based on what we know about price adjustment from empirical

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<sup>6</sup>As Romer points out, if  $\phi < 0$ , then producers will always to charge a price that is more than the prevailing price. This is inconsistent with the symmetric equilibrium assumption we made in order to solve the model. That is, it implies unstable behavior inconsistent with the definition of an equilibrium.



studies, this assumption seems unrealistic. Romer discusses this in more detail on 336-339.

### 6.5.2 Quantitative Example

Mathematically, the losses associated with leaving the price fixed are second-order losses. To see this, consider the following situation. There is a negative shock to aggregate demand. We know the firm's profit is defined as (let  $v = 1/(\gamma - 1)$ ):

$$\pi = Y \left( \frac{P_i}{P} \right)^{-\eta} \left( \frac{P_i}{P} - Y^{1/v} \right)$$

Now, incorporate the aggregate demand curve,  $Y = \frac{M}{P}$  :

$$\begin{aligned} \pi &= \frac{M}{P} \left( \frac{P_i}{P} \right)^{-\eta} \left( \frac{P_i}{P} - \left( \frac{M}{P} \right)^{1/v} \right) \\ \pi &= \frac{M}{P} \left( \frac{P_i}{P} \right)^{1-\eta} - \left( \frac{M}{P} \right)^{\frac{1+v}{v}} \left( \frac{P_i}{P} \right)^{-\eta} \end{aligned}$$

This is the profit for any given combination of  $P, M$ , and  $P_i$ . From the model presented above, we can find the profit maximizing  $P_i$  assuming there are no nominal rigidities.

$$\begin{aligned} \frac{P_i^*}{P} &= \frac{\eta}{\eta - 1} Y^{1/v} \\ \frac{P_i^*}{P} &= \frac{\eta}{\eta - 1} \left( \frac{M}{P} \right)^{1/v} \end{aligned}$$

Plugging this into the expression for profit above:

$$\begin{aligned} \pi_{ADJ} &= \frac{M}{P} \left( \frac{\eta}{\eta - 1} \left( \frac{M}{P} \right)^{1/v} \right)^{1-\eta} - \left( \frac{M}{P} \right)^{\frac{1+v}{v}} \left( \frac{\eta}{\eta - 1} \left( \frac{M}{P} \right)^{1/v} \right)^{-\eta} \\ \pi_{ADJ} &= \left( \frac{\eta}{\eta - 1} \right)^{1-\eta} \left( \frac{M}{P} \right)^{1+\frac{1-\eta}{v}} - \left( \frac{\eta}{\eta - 1} \right)^{-\eta} \left( \frac{M}{P} \right)^{\frac{1+v}{v} - \frac{\eta}{v}} \\ \pi_{ADJ} &= \left( \frac{M}{P} \right)^{\frac{1-\eta+v}{v}} \left[ \left( \frac{\eta}{\eta - 1} \right)^{1-\eta} - \left( \frac{\eta}{\eta - 1} \right)^{-\eta} \right] \\ \pi_{ADJ} &= \left( \frac{M}{P} \right)^{\frac{1-\eta+v}{v}} \left[ \left( \frac{\eta}{\eta - 1} \right)^{-\eta} \left( \left( \frac{\eta}{\eta - 1} \right) - 1 \right) \right] \\ \pi_{ADJ} &= \left( \frac{M}{P} \right)^{\frac{1-\eta+v}{v}} \left( \frac{\eta}{\eta - 1} \right)^{-\eta} \left( \frac{1}{\eta - 1} \right) \end{aligned}$$

where  $\pi_{ADJ}$  denotes profits when the firm does adjust its price.

Now, if the firm keeps its price unchanged at the initial equilibrium value, where  $P_i^* = P$ , then  $\frac{P_i}{P} = 1$ :

$$\pi_{FIXED} = \frac{M}{P} - \left(\frac{M}{P}\right)^{\frac{1+v}{v}}$$

Since  $\pi_{ADJ}$  is profit maximizing, we know that  $\pi_{ADJ} < \pi_{FIXED}$ . Suppose there is a menu cost, denoted  $Z$ . If  $Z > (\pi_{ADJ} - \pi_{FIXED})$ , then it is not worthwhile for the firm to change its price. The menu cost exceeds the gain in profit associated with changing the price.

Romer assumes some values for  $\eta$  and  $v$  in order to demonstrate that the size of  $Z$  would need to be unreasonably large in order to lead to a situation where firms would opt to leave their prices unchanged. Therefore, it is difficult to generate a situation where a change in aggregate demand actually affects output. Firms will adjust their prices in response to all but the smallest shocks - and these shocks would not have a large effect on output.

## 6.6 New Keynesian Approach: Real Rigidity

This section will provide a very brief overview of how real rigidities affect the analysis above. Please see Romer Chapter 6, pg. 294-310 for a more complete discussion. From the discussion above, we know that nominal rigidities alone are not sufficient to lead to situations where aggregate demand shocks (and therefore policy) affect real output.

### 6.6.1 General Considerations

Consider Romer's example above. Aggregate demand decreases, shifting the individual demand curves of each firm to the left. Assuming that the firms act simultaneously, no other firm has yet made a decision about its price. Each firm is faced with a choice: (i) reduce the individual price in nominal and relative terms, so that it sells at the optimal production level and earn  $\pi_{ADJ}$  or (ii) keep its nominal and relative price fixed and lower production to the smaller sales level supported by the reduced demand at the original price (e.g., a movement up the individual demand curve) earning  $\pi_{FIXED}$ . Non-neutrality results only if firms choose option (ii). If one firm chooses option (i), then all firms will (since we consider symmetric equilibrium where all the firms are identical) and the aggregate price will adjust in proportion to the monetary contraction that reduced aggregate demand, leaving real output unchanged.

### 6.6.2 Sources

When would a firm choose option (ii)? Significant real rigidity makes option (ii) less costly for the firms. For example, if firms' products are close substitutes (so that their demand is relatively elastic), then each firm will want its price to

stay close to those of its competitors. In other words, they are relatively more concerned about losing market share. That makes option (i) unattractive when other firms are not expected to change prices. Romer notes that strong real-price rigidity reduces the optimal amount of price adjustment (D-C in Figure 6.3) when the firm does adjust, reducing the benefits to adjustment.

However, the competitive labor market in Romer's quantitative example makes it almost impossible for firms not to adjust prices (and thus absorb the fluctuation by changing output) because labor supply tends to be inelastic. A labor-supply elasticity of 0.1, is consistent with empirical evidence, implies that a 3% decline in output, which would correspond to the 3% reduction in aggregate demand if no firm changed its price, would require a 30% decrease in the real wage in order for everyone to still be on their labor-supply curves.

This highlights a major point of contention between new Keynesian and RBC theorists. Assuming that we continue with a perfectly competitive labor market, New Keynesian models need to assume relatively elastic labor supply to generate results that are consistent with the data. The RBC approach allows for a more general specification, where one can assume a labor supply elasticity (10%) and generate business cycles that are consistent with the data.

As we will see in the discussion of unemployment (Chapter 9 in Romer), relaxing the assumption of perfect competition in the labor market may be warranted. If wages are sticky enough so that they do not fall 30% (because of a market failure), then the forces discouraging price adjustment are muted and non-adjustment is more likely. This leads us to a common conclusion drawn from new Keynesian models: small nominal *and* real rigidities in different parts of the model can build on each other and lead to much more substantial rigidity in the aggregate model. The key is that we do need real rigidities to generate these effects under a reasonable set of assumptions about the model's parameters. Similarly, we need nominal rigidities in order for aggregate demand to affect real output.

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