

Papers

3. Student Preferences when *Learning* Dynamics

Student Preferences when *Learning Dynamics*

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Abstract

This article compares learning preferences of students after they received two methods of instruction about business cycle dynamics. One instructional method utilized the aggregate supply and demand graph. The other method relied on feedback loops depicting aggregate supply and demand relationships. A statistically significant majority of students preferred the feedback loops over the graph.

JEL: A22, C91, E32

Key words: education, experiment, feedback, graph, macroeconomics, model

This is the second of two articles examining student preferences with regard to teaching and learning macroeconomics. In Wheat (2007b), students were placed in the hypothetical role of a *tutor* responsible for explaining macroeconomics. When required to choose a supplementary teaching method, a significant majority of students expressed a preference for system dynamics-based tools (stocks, flows, and feedback loops) over conventional tools (differential equations and static graphs). In the current paper, student preferences are analyzed again, but the perspective shifts. This time the focus is on students as *learners* who indicate which instructional method they find more persuasive after they experience both. Section 1 elaborates on the rationale for this experiment, and section 2 provides a brief introduction to feedback loop diagramming. The experiment is described in section 3. The results are presented in section 4 and discussed in section 5.

1. Misunderstand or Understand Incorrectly?

What's the problem? Do undergraduates have difficulty understanding the AS/AD model? Or, is it a different problem altogether and, in Colander's (1991, p. 106) words, they "understand it incorrectly"? For AS/AD fans, there is no good answer to this pair of questions. If students are capable of understanding, Colander's (1991, 1995) critique comes into play, in which he demonstrates the AS/AD model to be "confusing and logically flawed, ... a crutch ... that encourages students to understand incorrectly how aggregate disequilibrium forces operate."

In one of the tasks in the previously mentioned study, students-as-*tutors* had to choose between an AS/AD model and a feedback loop model when the task was to explain the sticky price theory of business cycles (Wheat 2007b). The students showed a statistically significant preference for the feedback loop method. The experiment reported here revisits that issue but in a very different way. In the previous *tutorial* experiment, students saw only the final slide extracted from a full presentation, and it was their instinctive response that revealed their preference. In the sticky price *learning* experiment described in this paper, students received an entire slideshow presentation, and their assessment would seem to be a more considered judgment. A third study of the same match-up between feedback loops and the AS/AD model

is reported in Wheat (2007d), and that experiment goes further and compares student performance when the two instructional methods are used. The “misunderstand” or “understand incorrectly” conundrum is not fully addressed by any of these experiments, but some of the findings appear to be relevant to the issues behind the questions.

The issues are not idle. The importance of the role of graphs in undergraduate economics education is unmistakable. Most economics instruction is spent in lecture mode (Becker and Watts, 1998), and most lectures to undergraduates rely on graphical representations of the economy (Kennedy 2000). Cohn et al. (2001) found popular modern textbooks containing 200 to 400 graphs, compared to about one-tenth that number in early 20th century texts. A clear exception is Kennedy’s (2000) text, which contains fewer than 20 graphs (although most are variations of the AS/AD model). The possibility that there is a general student difficulty understanding graphs is suggested by Cohn et al. (2001). In two experiments with undergraduates, they found the graphical approach to be no more effective than verbal instruction alone. In one case, verbal instruction was *more* effective. Neither graph was an AS/AD model.

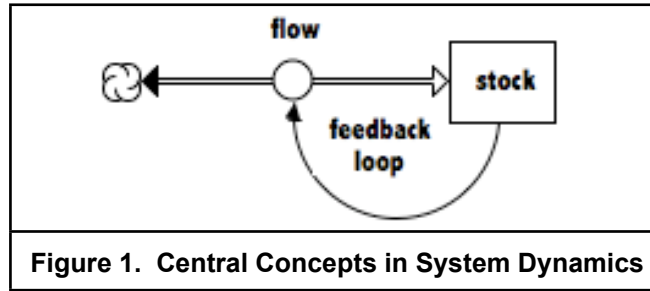
Although the focus on teaching methods in this paper concerns student preferences rather than instructional effectiveness, the issues are intertwined. If, as Cohn and his colleagues suggest, graphical instruction is less effective than generally assumed, the reasons may be clearer when viewed in the light of student opinion. One reason is the apparent connection between preference and performance. Nowaczyk et al. (1998) and Sankaran et al. (2000) found a positive correlation between preference and performance among undergraduates. Moreover, a manifestation of learning preference is the student’s self-described learning style, which Terry (2001) shows to be correlated with performance. Also, it is reasonable to infer that students prefer learning situations that evoke a high sense of self-efficacy, which Stevens et al. (2004) show to be correlated with performance.

2. The Feedback Method

In the experiment reported here, the alternative to the AS/AD instructional method is a feedback loop diagram that represents aggregate supply and demand in a different manner. It is part of an approach called the *feedback method*. It has been developed over the past five years to teach macroeconomics without excessive reliance on static graphs and equation manipulation. Utilizing the diagramming and simulation features of system dynamics modeling based on Forrester (1961) and Sterman (2000), the feedback method aims to make economic dynamics accessible to students who lack the mathematical training normally considered a prerequisite for such access.

Appendix II contains the slides provided to students using the feedback instructional method during the experiment. Those slides may provide readers with a sufficient overview of the feedback loop approach. Nevertheless, this section presents a brief introduction to feedback loop terminology and diagramming methods. The central concepts in system dynamics are stocks, flows, and feedback loops, illustrated generically in Figure 1. A *stock* is an accumulation of material or information. A net *flow* is the rate of change in a stock. A *feedback loop* is a closed loop of stocks and flows involved in a mutual causation process that occurs over time. When working with stock-and-flow models of complex systems such as an

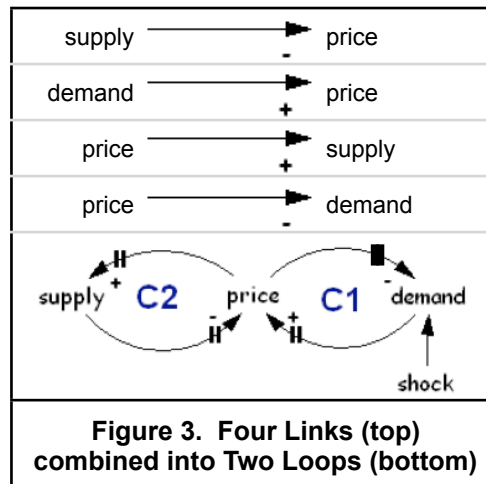
economy, a simplified version of the feedback loop is often more effective as a tool for communicating with non-specialists (e.g., undergraduates).



A loop contains at least two causal links, which are *ceteris paribus* hypotheses about cause-and-effect. A causal link is a word-and-arrow diagram similar to those that appear in some economics textbooks (Figure 2).

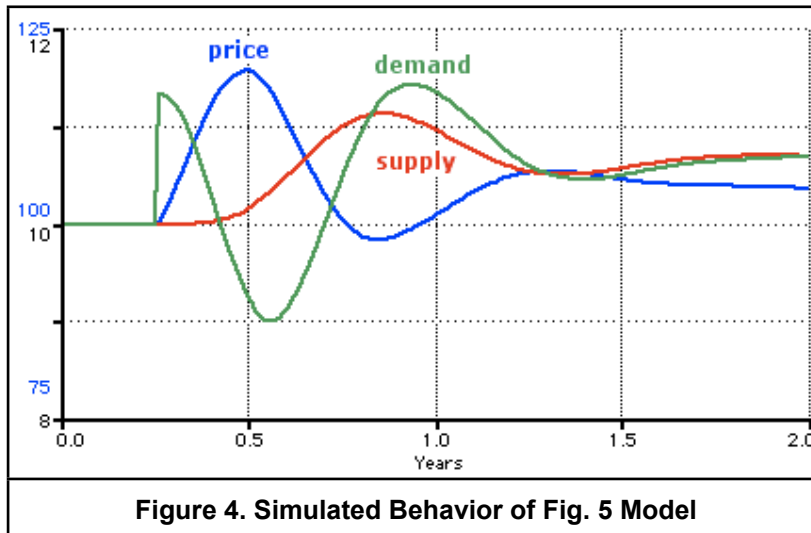


The minus sign (-) in Figure 2 means that price would *decrease* if supply *increased*. If the supply *decreased*, then price would *increase*. In other words, the negative polarity is suggestive of two variables moving in opposite directions. If the link had been labeled with a plus sign (+), that would suggest two variables moving in the same direction. Connecting links to form loops is a straightforward process. The four links in Figure 3, for example, can be combined into two feedback loops C1 and C2, where the cross marks (||) indicate the time delay inherent in each stock accumulation process.

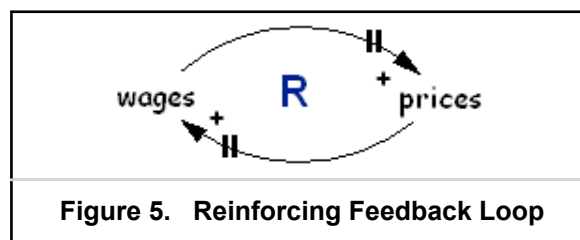


After an exogenous shock to demand, the simulated behavior arising from the hypothesized feedback structure is shown in Figure 4. To interpret the behavior in Figure 4, use the feedback structure in Figure 3. Begin by assuming that a permanent exogenous demand shock disturbs the equilibrium. After suppliers take time to evaluate the reliability of

the signal that demand has increased, price would rise.¹ The rising price would, in turn, put downward pressure on demand, but the full effect would occur gradually. Meanwhile, suppliers respond to the rising price by stepping up production, but it takes time to organize the requisite factors of production. When supply eventually responds, that puts downward pressure on prices, but with a delay. The damped oscillatory behavior and the amplitude and period for each curve depend on parameter assumptions for delay times and price elasticities.



When a feedback loop contains an *odd* number of negative signs, it will counteract or negate a previous trend. Such loops (e.g., C1 and C2 in Figure 3) are called *negative* or *counteracting* or *balancing* loops. Each term has the same meaning, and they are used interchangeably. The other type of feedback loop is called *positive* or *reinforcing*; again, the terms are synonymous. Figure 5 illustrates the reinforcing loop implicit in the familiar wage-price spiral hypothesis. A “walk-around-the-loop” shows that it feeds on itself and reinforces an initial trend. Confirmation comes from counting an *even* number of negative links (namely, zero) around the loop.



3. The Experimental Design

Each student received two instructional treatments about the sticky price theory of business cycles. One treatment (G) relied on a *graph* of aggregate supply and demand. The other method (F) relied on system dynamics-based *feedback loops* depicting aggregate

¹ In Blinder’s(1997) survey of 186 companies that represented about 85 percent of the private, non-farm GDP, he found “the typical lag of a price change behind a shock to either demand or cost is about three months.”

supply and demand relationships. Students were randomly assigned to two groups, and each group received both instructional treatments but in a different sequence. Group A received the graphical instruction first, while Group B was receiving the feedback loop instruction. After a short break following completion of the first round, the process was repeated with Group A and B switching methods.

Students in both groups worked alone at individual computers and used slideshow software. The first eight slides were identical for both groups. Figures 6 and 7 display the students' learning objectives and the overview of their task.

<p><i>Successful completion of this learning activity should enable you to...</i></p> <ul style="list-style-type: none"> • <i>describe what is meant by "business cycles" in the economy,</i> • <i>summarize the "sticky prices theory" of business cycles,</i> • <i>decide for yourself whether this theory provides a clear and convincing explanation of business cycle behavior.</i>
<p>Figure 6. Learning Objectives (slide 2)</p>

<p><i>What you will do:</i></p> <ul style="list-style-type: none"> • <i>Read a brief description of business cycles and some tentative explanations (hypotheses) known as the "sticky prices theory."</i> • <i>Study a series of diagrams and graphs designed to demonstrate the validity of the "sticky prices theory" of business cycles.</i> • <i>Answer some questions after studying the diagrams and graphs.</i>
<p>Figure 7. Student Task (slide 3)</p>

Slides 4-6 presented one stylized and two historical time series graphs illustrating business cycle patterns. A graph of GDP over the 1964-2004 period was accompanied by this description:

Over short time periods, GDP fluctuates around its long-run trend. Such fluctuations are called business cycles, even though they are not smooth up-and-down patterns.

An unemployment rate graph over the same forty-year period provided "even clearer evidence of business cycles in the U.S. economy." Slide 7 provided perspective on the very idea of explaining business cycles. The text emphasized that there is no single cause of business cycles and that "many theories" have been proposed. To lay the foundation for the task in the experiment, the text stressed that

Each theory is based on a set of hypotheses about how the economy works. Hypotheses are tentative explanations that require clear and convincing support before they can provide a foundation for a theory.

In conclusion, slide 7 re-emphasized the primary objective of the activity:

In this learning activity, you will evaluate one theory of business cycles, called the “sticky prices” theory. In the next slide, you will see some important hypotheses for that theory. In later slides, you will study diagrams and graphs designed to provide support for those hypotheses. You will be the one who decides if the support provided is “clear and convincing.”

Figure 8 reproduces slide 8, which defined sticky prices and business cycles and provided a text-only description of some hypotheses implicit in the theory.² After the textual overview, the students with instructional method G encountered several slides explaining how to read and interpret an aggregate supply and demand (AS/AD) graph, followed by more slides that used the graph to illustrate the sticky price theory. Slides 9-19 for Method G are reproduced in Appendix I.

<p>Definitions:</p> <ul style="list-style-type: none"> • <i>Sticky Prices: prices that adjust slowly to changes in the economy (also called “rigid” or “sluggish” prices).</i> • <i>Business Cycles: fluctuations above and below an economy’s growth trend.</i>
<p>Hypotheses:</p> <ul style="list-style-type: none"> • <i>When economic conditions change (for example, consumers cut back on spending), some business firms are slow to adjust their prices.</i> • <i>When sales decline, such firms—being slow to cut prices—will cut back on production and employment.</i> • <i>The employment cutback reduces household incomes, causing consumer demand—and sales—to decline even more.</i> • <i>Sticky prices cause the economy to depart from its growth trend, resulting in business cycles.</i>
<p>Figure 8. Sticky Price Theory of Business Cycles (Slide 8)</p>

The corresponding slides for instructional method F explained how to read and interpret reinforcing and counteracting feedback loops, followed by instruction that used those loops to illustrate the theory. Slides 9-34 for method F are reproduced in Appendix II. Upon completion of each instructional “lesson,” students had to consider whether it supported specific hypotheses implicit in the sticky price theory.

You will now evaluate this learning activity (“the lesson”). You will need to decide if the lesson provided “clear and convincing” support for the hypotheses that provide the foundation for the sticky prices theory of business cycles. You will not be asked whether you agree with the hypotheses. Instead, you will be asked whether you think the lesson provided support for the hypotheses.

² The summary version of the sticky price theory and the AS/AD diagram used with method G were adapted from DeLong (2002, ch. 9), Hall & Taylor (1997, ch. 8-9), Mankiw (2002, ch. 9; 2004, ch. 20).

The students had to consider seven such hypotheses that were adapted from the list in Figure 8. Figure 9 lists those seven hypotheses or “theories” (T1-T7), as they will be called in this paper.³ There was also a written reminder for the students, emphasizing that they were not being asked to agree or disagree with the *content* of a particular theory. Instead, they were being asked whether the *lesson provided “clear and convincing support” for the theory.*

Figure 9 includes two additional statements requiring a student response after each instructional treatment. Labeled E1 and E2, responses to those two statements were intended to indicate a student’s sense of *efficacy* with respect to understanding and explaining the sticky price theory. The response options for T1-T7 and E1-E2 were structured in a five-point Likert scale. When the results were analyzed, arbitrary values of 2, 1, 0, -1, -2 were assigned to *strongly agree, agree, unsure, disagree, and strongly disagree*, respectively.

Indicate how much you agree or disagree that the lesson provided clear and convincing support for each of these theories, T1-T7:
<i>T1. When sales decline and inventories grow too much, firms that are slow to cut prices will cut back on employment and production.</i>
<i>T2. A reduction in production nationwide causes a reduction in household income nationwide.</i>
<i>T3. A reduction in household income causes sales to decline even more.</i>
<i>T4. The longer it takes for prices to adjust to changes in demand, the more inventory will fluctuate above and below its normal level.</i>
<i>T5. The longer it takes for prices to adjust to changes in demand, the more the economy departs from its normal trend.</i>
<i>T6. The longer it takes for prices to adjust to changes in demand, the more GDP will fluctuate above and below its normal trend.</i>
<i>T7. The longer it takes for prices to adjust to changes in demand, the more the unemployment rate will fluctuate above and below its normal level.</i>
Indicate how much you agree or disagree with statements E1 and E2:
<i>E1. Diagrams and graphs in this lesson helped me understand the sticky price theory.</i>
<i>E2. I can now explain the sticky price theory of business cycles to someone else.</i>
Figure 9. Likert Scale Statements for Measuring Student Preferences for Instructional Methods G or F

Measurement. Preferences were not measured directly. Operationally, they were measured by comparing students’ Likert scale scores for the two instructional methods. Two measurement techniques were used. First, students’ relative assessment of the persuasiveness of the two instructional methods was taken as an indicator of preference. In short, it was assumed that students would prefer to be taught by the method they found more persuasive. The second indicator of preference was the students’ relative sense of efficacy with respect to understanding and explaining the sticky price theory. It was assumed that

³ The students saw the term “hypothesis” during the experiment, with the connotation that each hypothesis was a tentative sub-theory within the broader sticky price theory. In this paper, however, the statements in Figure 9 will be called “theories” instead of “hypotheses” to avoid confusion with the hypotheses being tested in the experiment.

students would prefer to be taught by a method they found easier to understand and explain to others. Thirteen comparisons were made: separate tests for the nine statements (S) in Figure 9, and four aggregate tests based on summing student responses to all statements.

Separate Likert Scores. Let L_{GS} refer to the mean Likert scale score assigned by students to the graphical instruction method G for statement S. Then L_{FS} is the mean score assigned by the students to the feedback method F for statement S. The null hypothesis was

$$H_{0S}: L_{GS} = L_{FS}$$

and statistical assessment of student preferences utilized paired t-tests and a 0.05 significance level.

Aggregate Likert Scores. The paired t-test was also used to evaluate *aggregate* measures of student preferences on all nine statements taken together. To that end, students' scores for individual statements were summed for G and F separately. Let the bold non-italicized L_G refer to the mean aggregate Likert scale score for the graphical instruction method G. Then L_F is the mean aggregate score for the feedback method F. The null hypothesis for the aggregate test was

$$H_0: L_G = L_F$$

and the aggregate paired t-tests were conducted with both pooled and group data, with a 0.05 significance level.

Aggregate Proportion Test. The most straightforward test compared the proportion of students who preferred each method. Let P_G represent the proportion of students with an aggregate Likert scale score for method G greater than the aggregate Likert scale score for method F. Then $P_F = 1 - P_G$ and the null hypothesis was

$$H_{0P}: P_G = P_F$$

and this hypothesis was evaluated by a t-test for proportions at the 0.05 significance level.

Sample Selection and Characteristics. The experiment was conducted in December 2004, with thirty-seven dual enrollment political science students at Virginia Western Community College in Roanoke, Virginia. They volunteered to get "extra credit" for participating in the experiment. Although they were taking a college-credit political science course through the community college, the students were part of a select group of advanced high school seniors participating in a dual enrollment honors program. They were taking courses that would earn both high school and college credits. Many had a strong mathematics background and were experienced in graphical analysis, although not with comparative statics. They were one year away from being "real" university undergraduates, but they had exceptional ability and were unquestionably college-bound. In terms of intellectual maturity at the time of the experiment, they would probably rank as high as the average university undergraduate.

4. Results

The *proportion* test results are displayed in Figure 10.⁴

	P_G	P_F	p
all students	10.8	89.2	.0001

Figure 10. Results of Proportion Test

The results for the *separate Likert* tests are presented in Figure 11. The null hypothesis was rejected in each case.⁵

	Mean Likert Score		p
	L _{GS}	L _{FS}	
The lesson provided clear and convincing support for theories T1-T7:			
T1. <i>When sales decline and inventories grow too much, firms that are slow to cut prices will cut back on employment and production.</i>	0.87	1.46	.003
T2. <i>A reduction in production nationwide causes a reduction in household income nationwide.</i>	0.70	1.43	.001
T3. <i>A reduction in household income causes sales to decline even more.</i>	0.92	1.70	.001
T4. <i>The longer it takes for prices to adjust to changes in demand, the more inventory will fluctuate above and below its normal level.</i>	0.57	1.49	.001
T5. <i>The longer it takes for prices to adjust to changes in demand, the more the economy departs from its normal trend.</i>	0.73	1.43	.001
T6. <i>The longer it takes for prices to adjust to changes in demand, the more GDP will fluctuate above and below its normal trend.</i>	0.68	1.38	.001
T7. <i>The longer it takes for prices to adjust to changes in demand, the more the unemployment rate will fluctuate above and below its normal level.</i>	0.51	1.43	.001
E1. <i>Diagrams & graphs in this lesson helped me understand the sticky price theory.</i>	0.41	1.62	.000
E2. <i>I can now explain the sticky price theory of business cycles to someone else.</i>	0.08	1.00	.000

Figure 11. Results of Separate Tests
(maximum possible score = 2.00)

⁴ Raw data are listed in appendix IV. In Figure 10, the t-test for proportions (with a null hypothesis that the proportion of students favoring each method would be 0.50) yielded a t value of 7.57 with 36 degrees of freedom.

⁵ Raw data are listed in appendix IV. In each paired t-test for Figure 11, degrees of freedom = 34. The t values were 3.17, 3.65, 4.12, 4.62, 3.88, 3.71, and 4.90 for T1-T7, and 5.15 and 5.01 for E1-E2 respectively.

The results for the *aggregate Likert* tests are presented in Figure 12. Again, the null hypothesis was rejected.⁶

Student Group	Mean Aggregate Likert Score		p
	L_G	L_F	
A	4.89	13.90	.001
B	3.94	11.90	.003
pooled	5.46	12.90	.000

Figure 12. Results of Aggregate Tests
(maximum possible score = 18.00)

The aggregate group tests indicate that the results were not dependent on the sequence of instructional methods. Both student groups preferred the feedback method, whether it was received before or after the graphical method. Moreover, the degree of preference (measured by the difference between L_F and L_G) was similar for both groups.⁷

5. Discussion

Since this experiment was similar to a previous task in Wheat (2007b), it provides an opportunity to apply what was learned about student motivations in that previous experiment. There, students were asked to *explain* their selection of a teaching tool (the graph or the feedback loop). The explanations tended to stress that the feedback loop was more descriptive of a real-world process. The mutual causation implicit in the feedback loop diagram was also emphasized. Those same reasons seem relevant here. All seven “theories” in Figure 9 are about dynamic processes. They emphasize disequilibrium rather than equilibrium. They imply time-delayed mutual causation. In short, those theories refer to precisely the kind of behavior that feedback loop diagrams describe (and their underlying stock-and-flow structures generate).

Both instructional methods were delivered in slideshow format, and the first eight slides were identical. The distinctive slides for each method are reproduced in Appendix I (for the graphical method) and Appendix II (for the feedback method). An obvious difference between the two methods is that the feedback method used twenty-six distinctive slides, compared with just eleven for the graphical method. Most students completed the graphical instruction slideshow in about twenty minutes, while the feedback loop instructional slideshow required about thirty minutes. It is possible, therefore, that the students’ relative preference for the feedback method was influenced by the additional time devoted to it. About half of the “extra” slides were little more than extra steps in drawing the loops. It should not be difficult to equalize the presentation of the two diagrams. However, eight of the extra slides (25-28, 31-34) in method F displayed simulation results from the stock-and-flow model that was the basis for the feedback loop diagram. That should have been beneficial to the students in that group and may represent an unfair advantage for the

⁶ Raw data are listed in appendix IV. For group A in Figure 12, $t = 3.75$ with 18 degrees of freedom. For group B, $t = 3.53$ with 17 degrees of freedom. For the pooled test, $t = 5.19$ with 36 degrees of freedom.

⁷ There was no significant difference between ability levels of the two groups, based on mean course grades, which were 88.9 and 89.5 for groups A and B, respectively ($t = 0.31$ with 35 d.f.).

feedback loop method. The counter-argument is that the small time series graph in the corner of the AS/AD slides already shows the implicit simulated effects of the shifting SRAS curve.

More to the point is the question of whether graphical presentations typically make use of simulation tools that are functionally related to the graphs. The answer is almost certainly no. That it does not is in marked contrast to system dynamics modeling, where simulation and feedback loop analysis is central to the process of inferring behavior from structure. Ultimately, on the question of whether the content of the two instructional methods was fairly presented, readers will have to form an independent judgment by reviewing the slides reproduced in the appendices.

One other issue that bears on internal validity should be noted. About *three months before* the experiment, the students received a brief (approximately fifteen minute) impromptu lesson on counteracting feedback as a way of thinking conceptually about public policy formation as a corrective process. That “lesson” was *not* part of the autumn curriculum, and there was no additional exposure to system dynamics concepts until the December experiment. It is unlikely—but possible—that a quick look at a single feedback loop in a political context in September would have biased the results in favor of the feedback method in a December economics experiment. However, *if* the brief September lesson had such a profound effect in December in a different context, that in itself might be a strong argument for feedback methods of instruction.

This experimental design has its weaknesses. When replicating or adapting the experiment, future researchers should modify the content of the instructional materials to achieve time-on-task parity and scrutinize more closely the content in both instructional methods to minimize the potential for bias. Also, the scope of the research should be widened to investigate the impact of process visualization on both student learning preferences and student learning efficiency when studying dynamics. That may provide some answers to the preference/performance question. Moreover, it may indicate why graphical instruction seems to be less effective than heretofore assumed. Finally, it may explain why the feedback method is a promising alternative for motivating students to learn about the structure and behavior of dynamic systems.

Postscript. Although unrelated to the preference question that is the subject of this paper, the test instrument collected one additional interesting piece of information. It gauged the instructional methods’ effect on the students’ final judgment of the sticky price theory. We wanted to know if the students went away *believing* that the sticky price theory explains business cycle patterns in the United States and if one teaching method was more effective in forming that belief. To that end, students were required to respond to a tenth statement: *The sticky price theory explains the historical pattern of U.S. business cycles.*

The mean pooled response score was 0.81 following the second round of instructional treatments, a score that is significantly different from the “unsure” score of zero ($t = 4.48$ with 36 degrees of freedom, and $p < .0001$). In addition, the students gave the feedback method more credit for a convincing demonstration of the theory’s explanatory power, regardless of which instructional method was received first. For those in group B who received the feedback method treatment first, the difference was not statistically significant.

However, the effect was in the same direction and almost as strong as the effect in group A, which was statistically significant, as were the pooled results. See Figure 13.

<i>T. The sticky price theory explains the historical pattern of U.S. business cycles.</i>			
Student Group	Mean Aggregate Likert Score		p
	L _{GT}	L _{FT}	
A	0.58	1.16	.01
B	0.44	1.00	.15
pooled	0.51	1.08	.01

Figure 13. Results of Theory Belief Test (maximum possible score = 2.00)

Of course, there was *no empirical basis* for student opinion on this question. Although earlier slides depicted time series graphs of historical business cycles, the students had no data on historical price stickiness. Nevertheless, they *did* form an opinion. Explaining such opinion formation requires a Bayesian perspective: for students with no prior theory about business cycles, any plausible hypothesis may form an impression that establishes itself as the student's dominant mental model.

This raises an ethical and pedagogical issue that is beyond the scope of this paper but deserves vigilance; namely, the extent to which a single-theory explanation of any process is presented "impressively" to students who have weak prior mental models. The need for presenting and comparing alternative theories is self-evident. When empirical comparisons are possible, student assessment of competing theories should be fostered. When simulation capabilities exist, students should "test drive" alternative theories and evaluate robustness.

Shaping students' mental models is what instructors do. We should be judicious in the exercise of that power.

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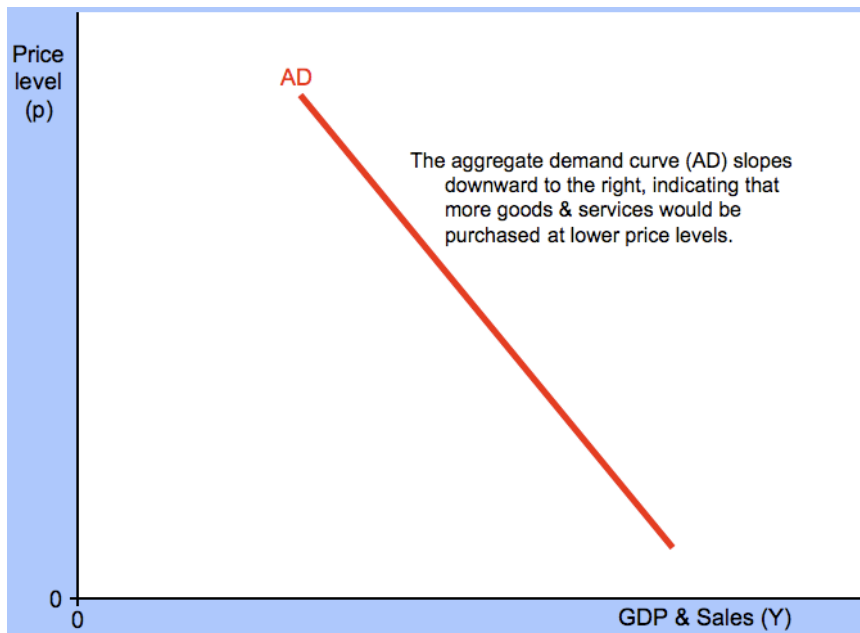
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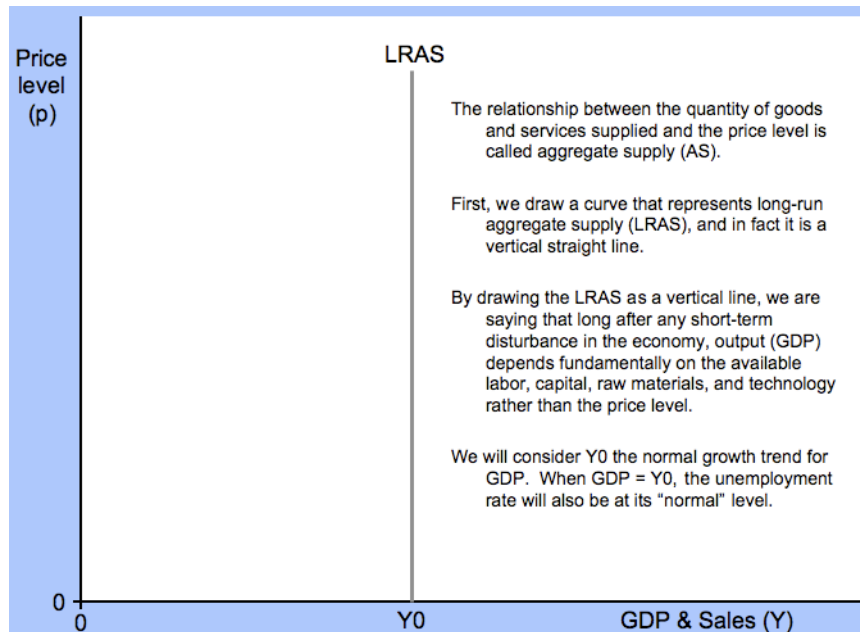
Appendix I. Slides 9-19 for the Graphical Instruction Method (G)⁸

Slide 9, Method G: We will build a simplified version of the economy — a “model” that illustrates how an economic system works. Then we will see how the sticky prices theory fits into our model. We begin by drawing a graph, with “GDP & Sales” on the horizontal axis (below) and the average price level on the vertical axis (left). GDP is “gross domestic product” — a nation’s annual production of final goods & services — aggregate supply. Sales refers to actual spending on goods & services nationwide — aggregate demand. When aggregate demand is equal to aggregate supply, the economy will be in equilibrium. The average price level, however, will influence that equilibrium point.

Slide 10, Method G:

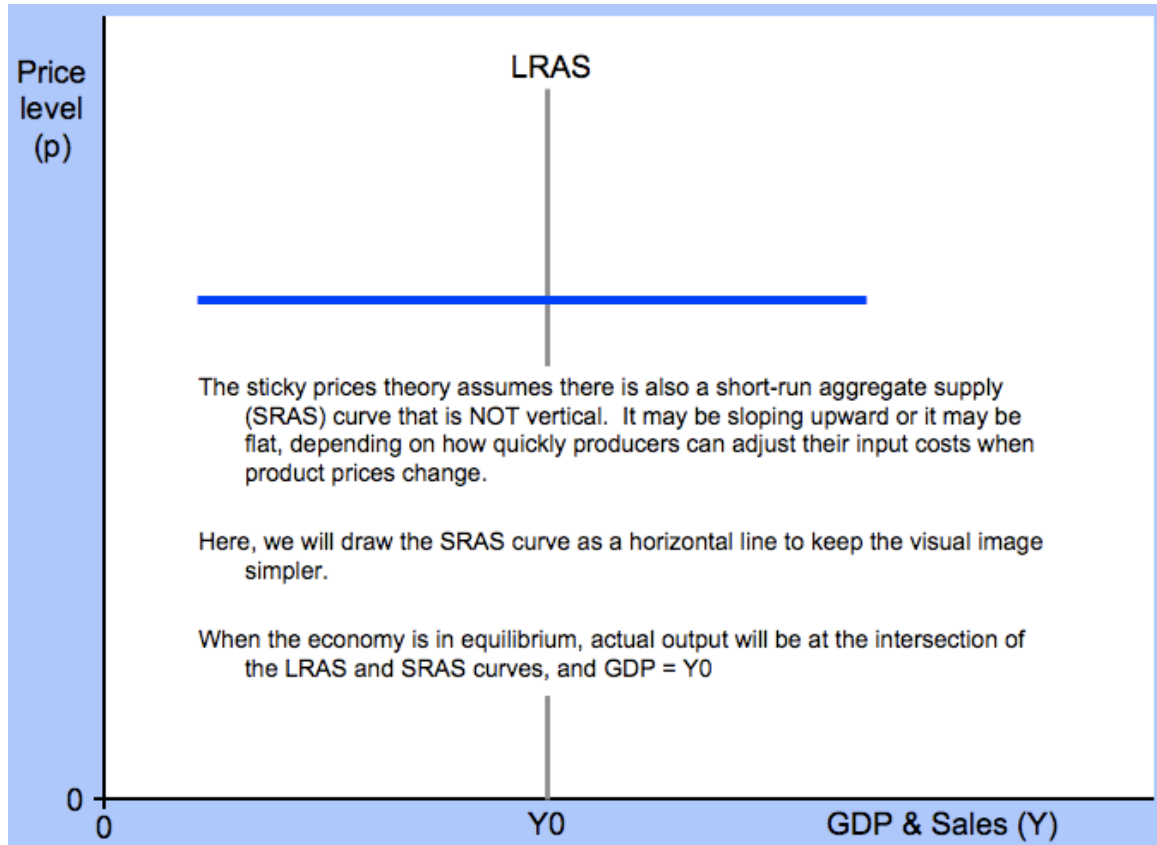


Slide 11, Method G:

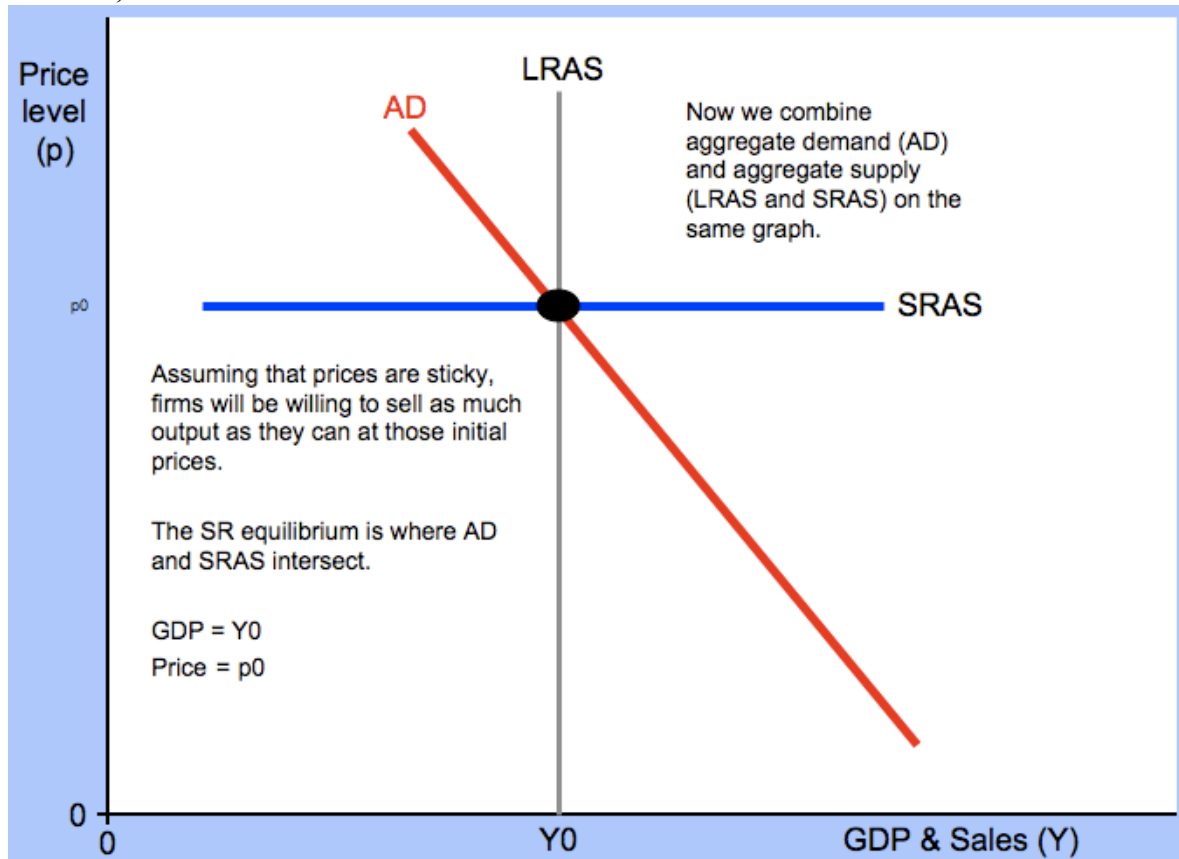


⁸ The AS/AD graph in Method G is adapted from Hall & Taylor (1997, chapters 8-9), Mankiw (2002, chapter 9), and Mankiw (2004, ch. 20). Mankiw (2002) uses horizontal SRAS curves, while Mankiw (2004) uses upward sloping SRAS curves. Hall & Taylor use horizontal lines that imply a price-determining intersection with the AD curve, but do not explicitly refer to the lines as SRAS curves.

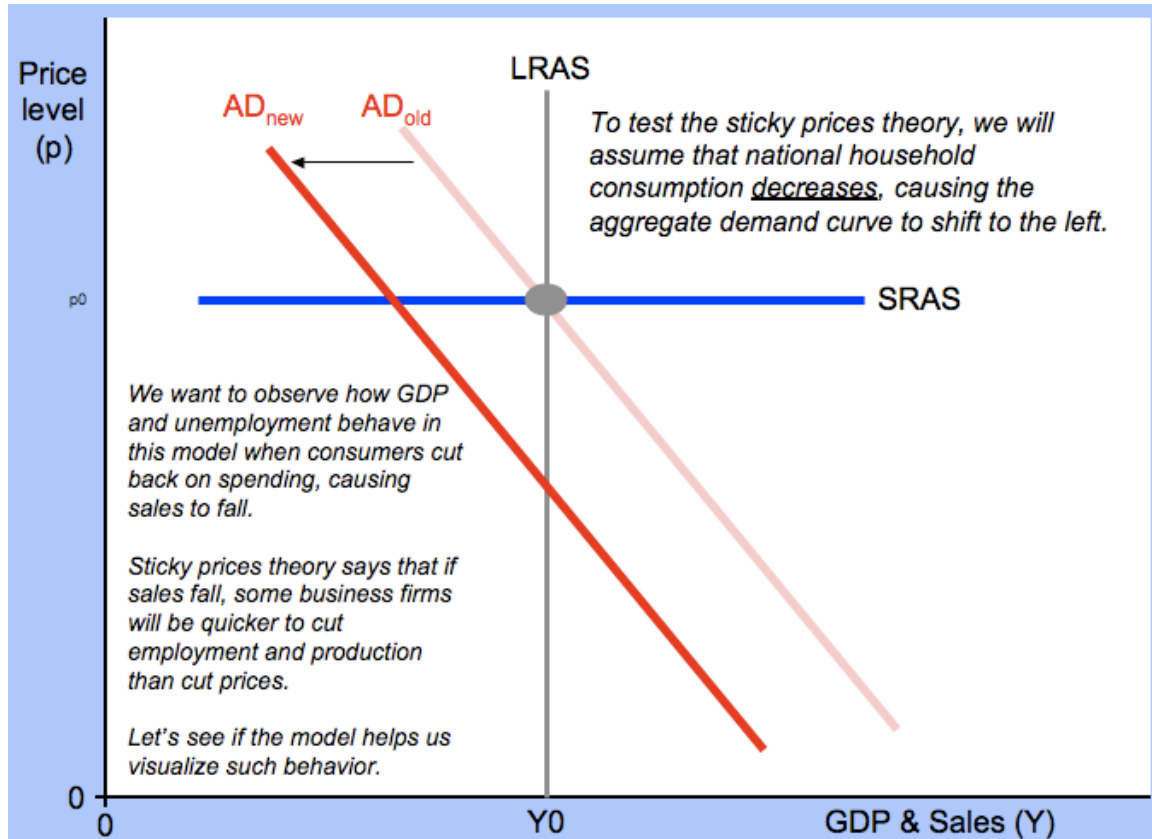
Slide 12, Method G:



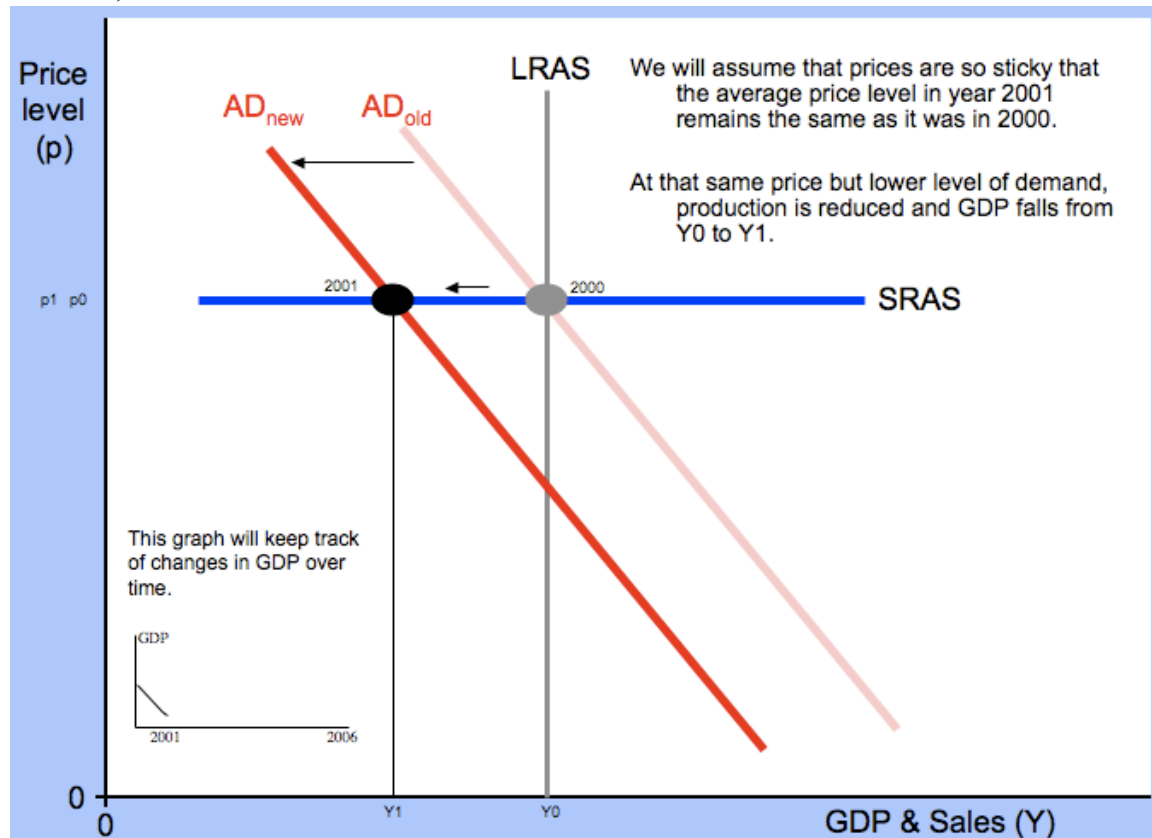
Slide 13, Method G



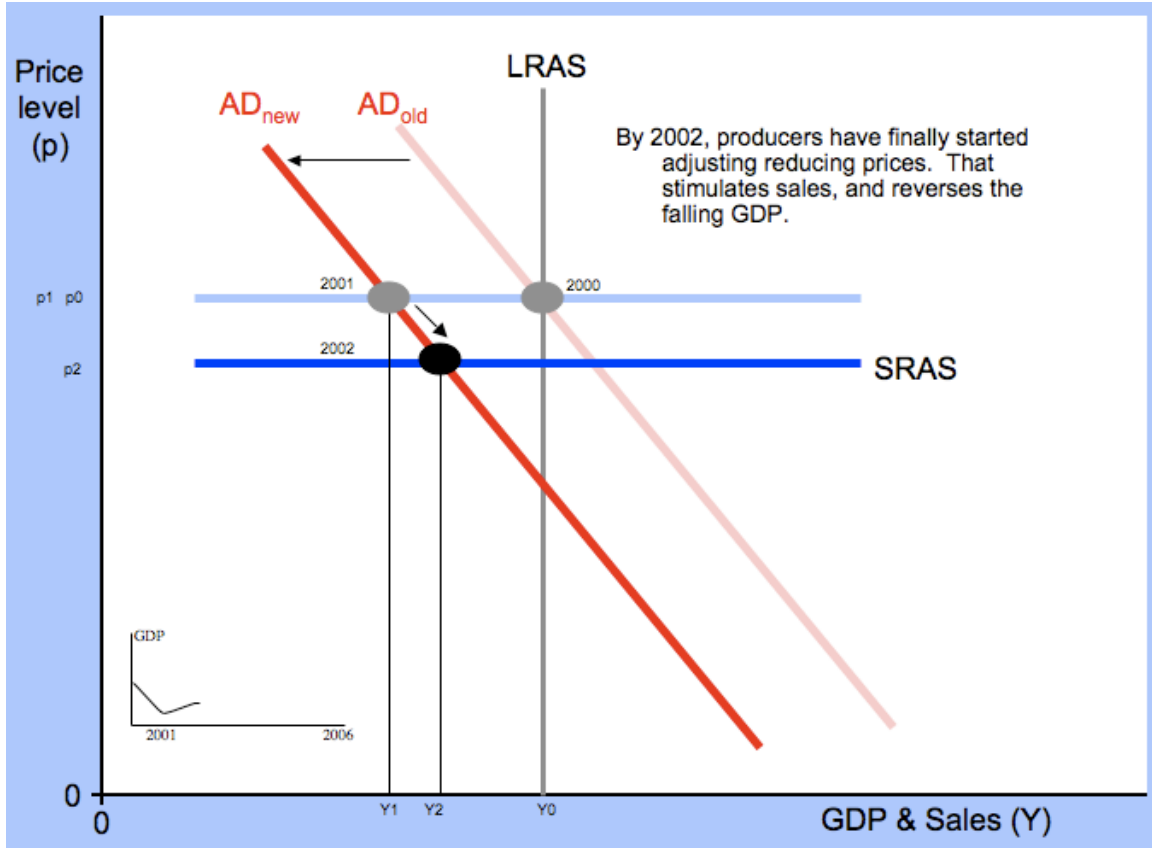
Slide 14, Method G:



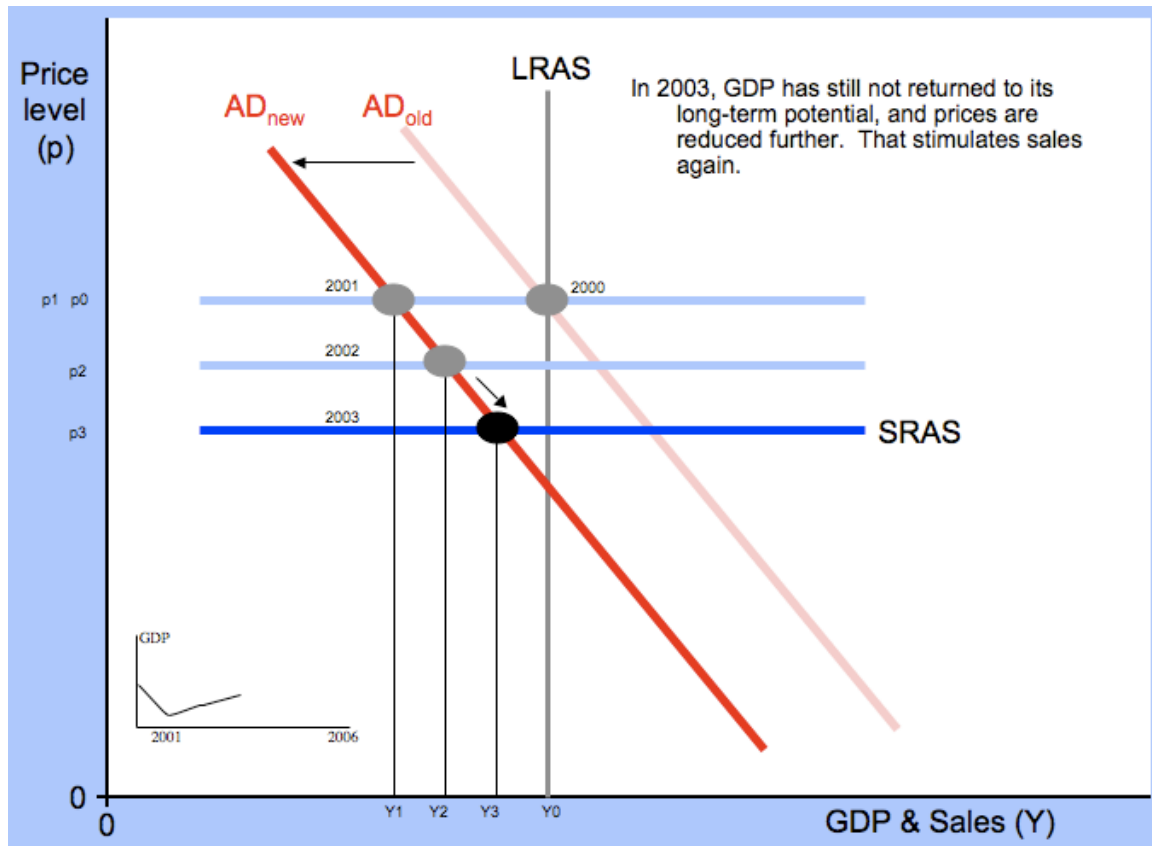
Slide 15, Method G:



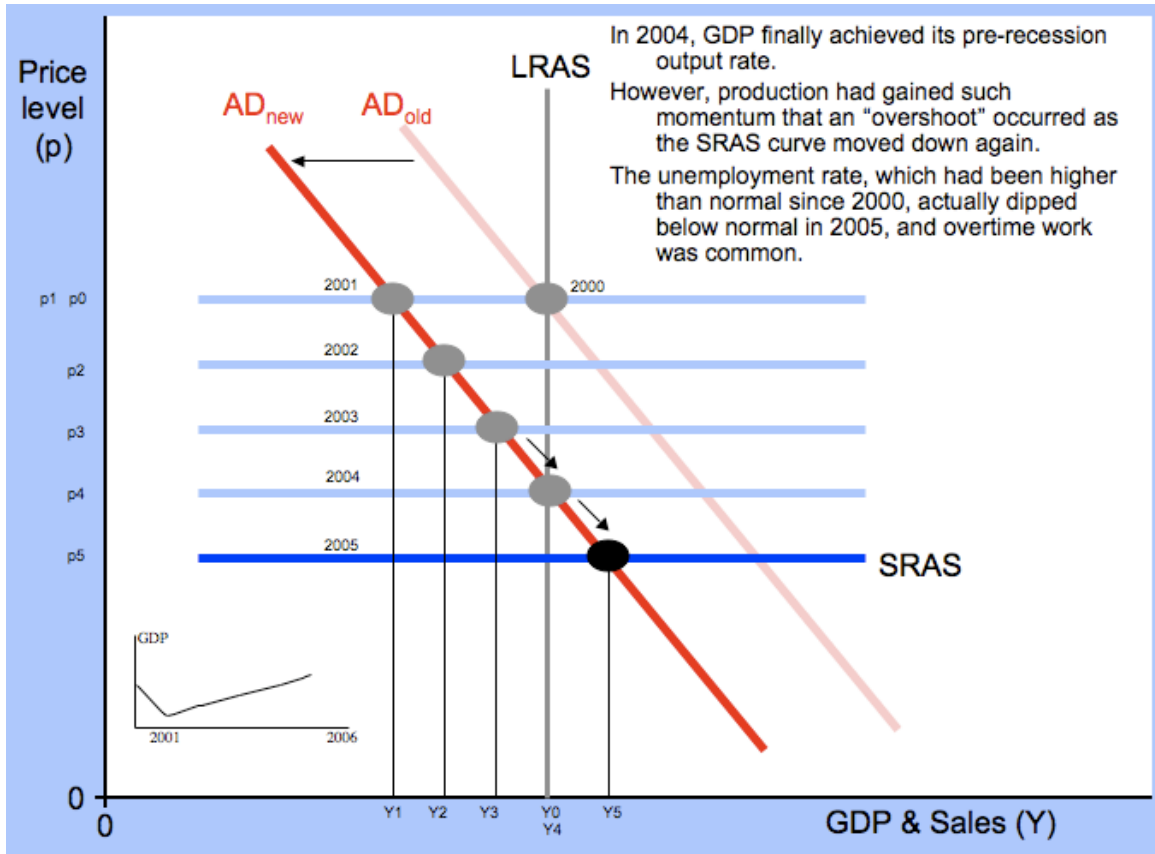
Slide 16, Method G:



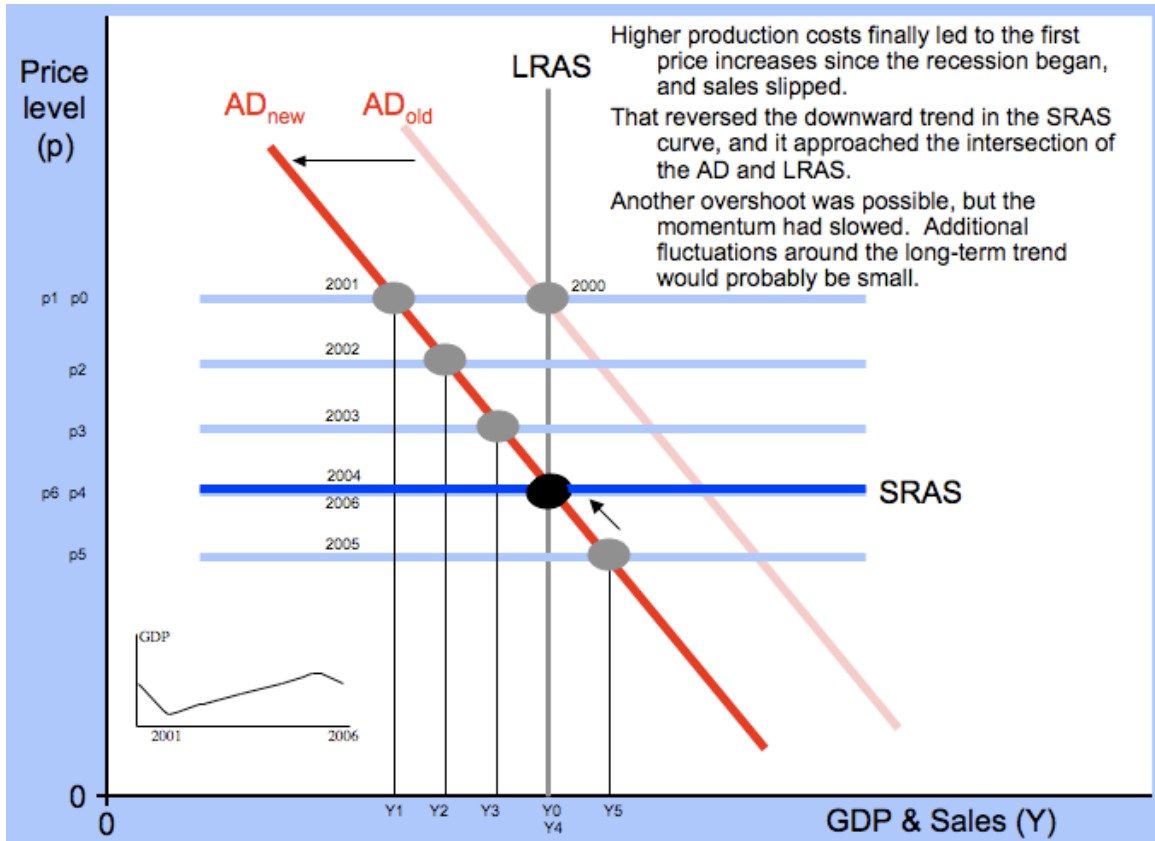
Slide 17, Method G:



Slide 18, Method G:

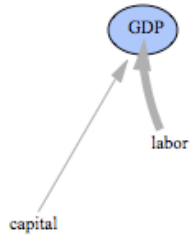


Slide 19, Method G:



Appendix II. Slides 9-34 for the Feedback Instructional Method (F)

Slide 9, Method F:




We will build a simplified version of the economy--a "model" that illustrates how an economic system works. Then we will see how the sticky prices theory fits into our model.

We begin by defining gross domestic product (GDP). GDP is a nation's annual production of final goods and services.

Production results from a combination of labor and capital equipment.

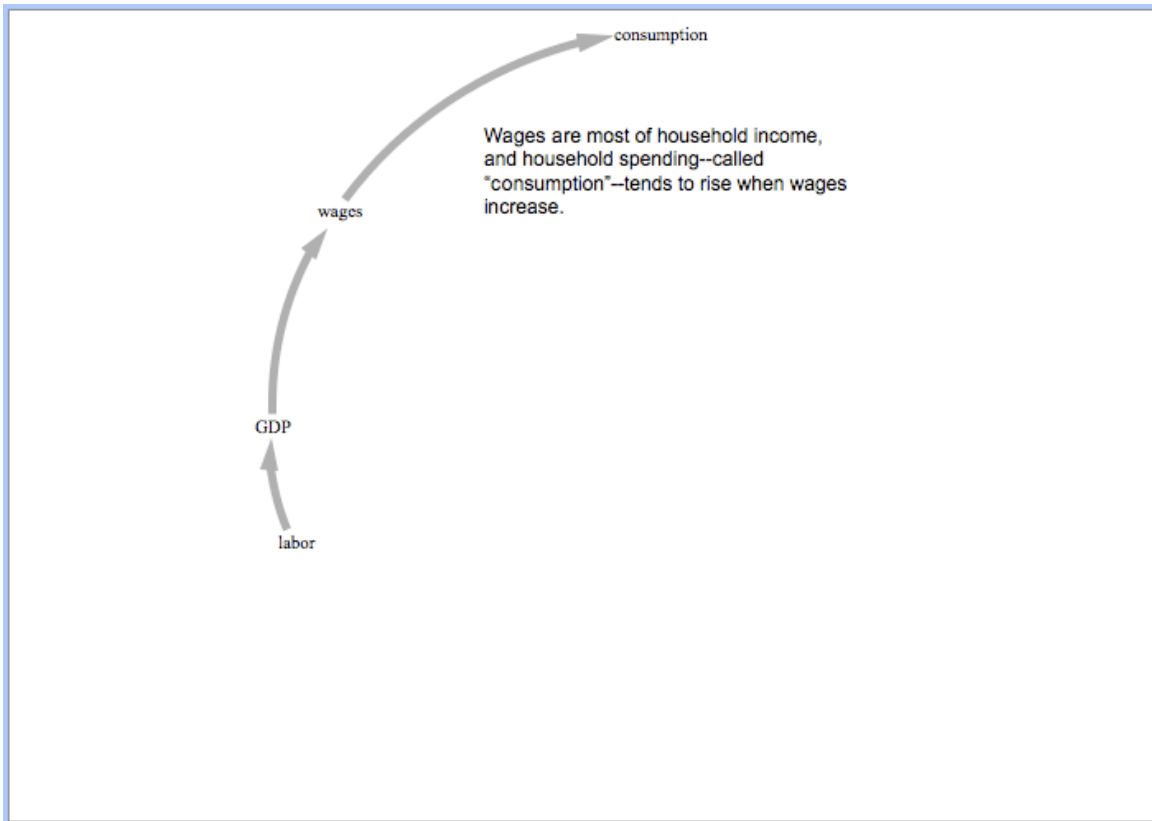
Slide 10, Method F:



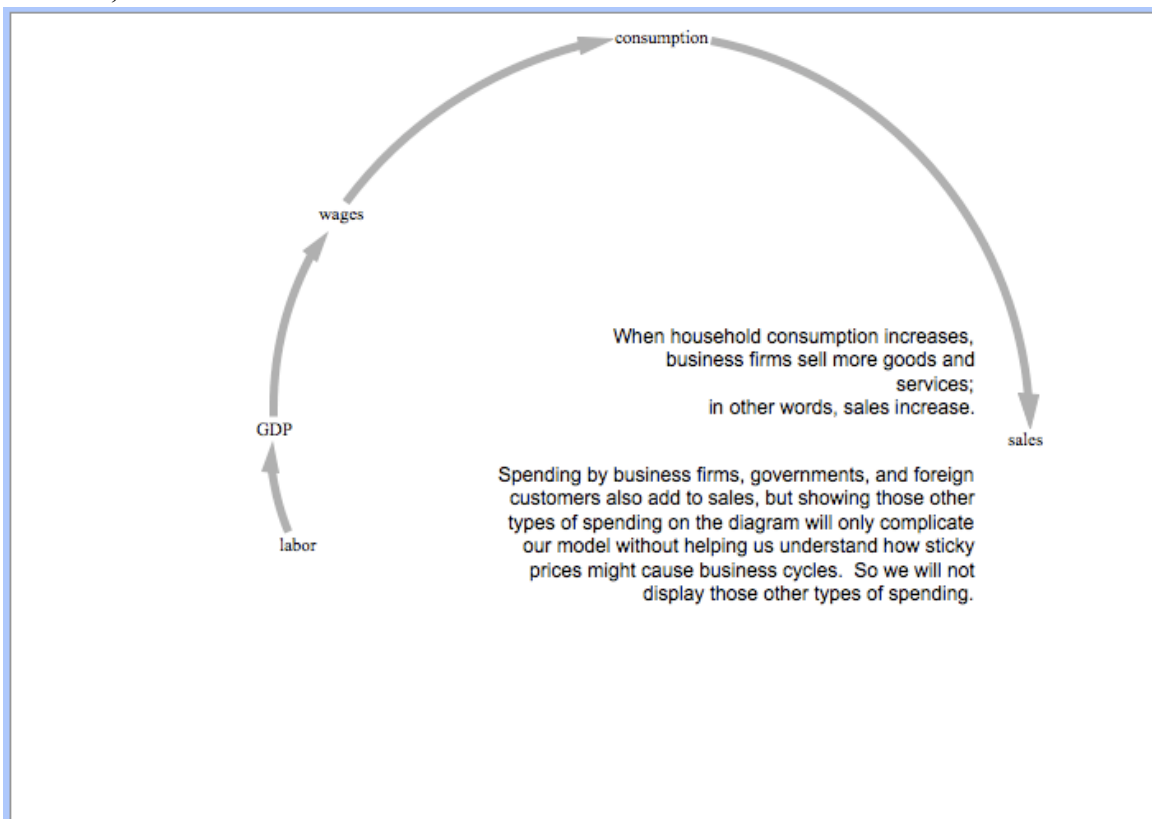
After production occurs, wages are paid to households that contributed their labor to the production process.

Since we will focus on short-run causes of business cycles and since changes in the amount of plant and equipment occur much slower than changes in the amount of labor employed, we will delete changes in capital from the model to keep it as simple as possible.

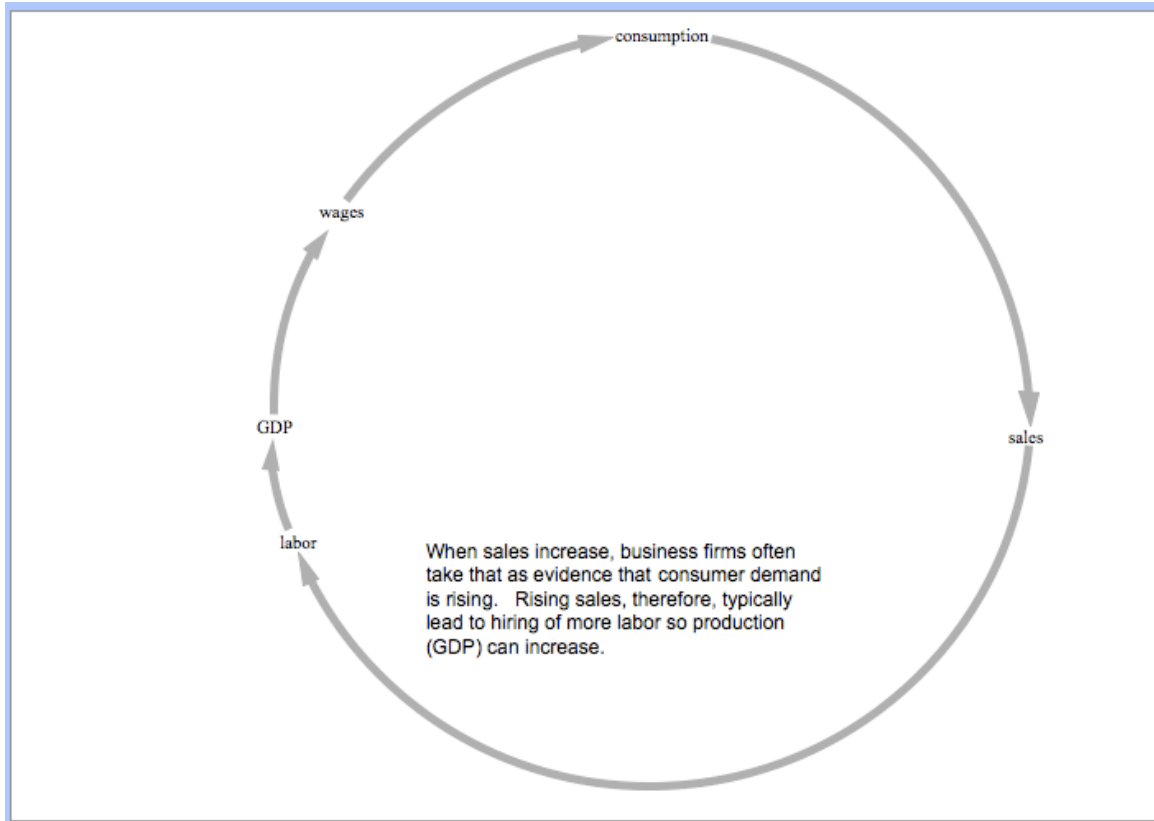
Slide 11, Method F:



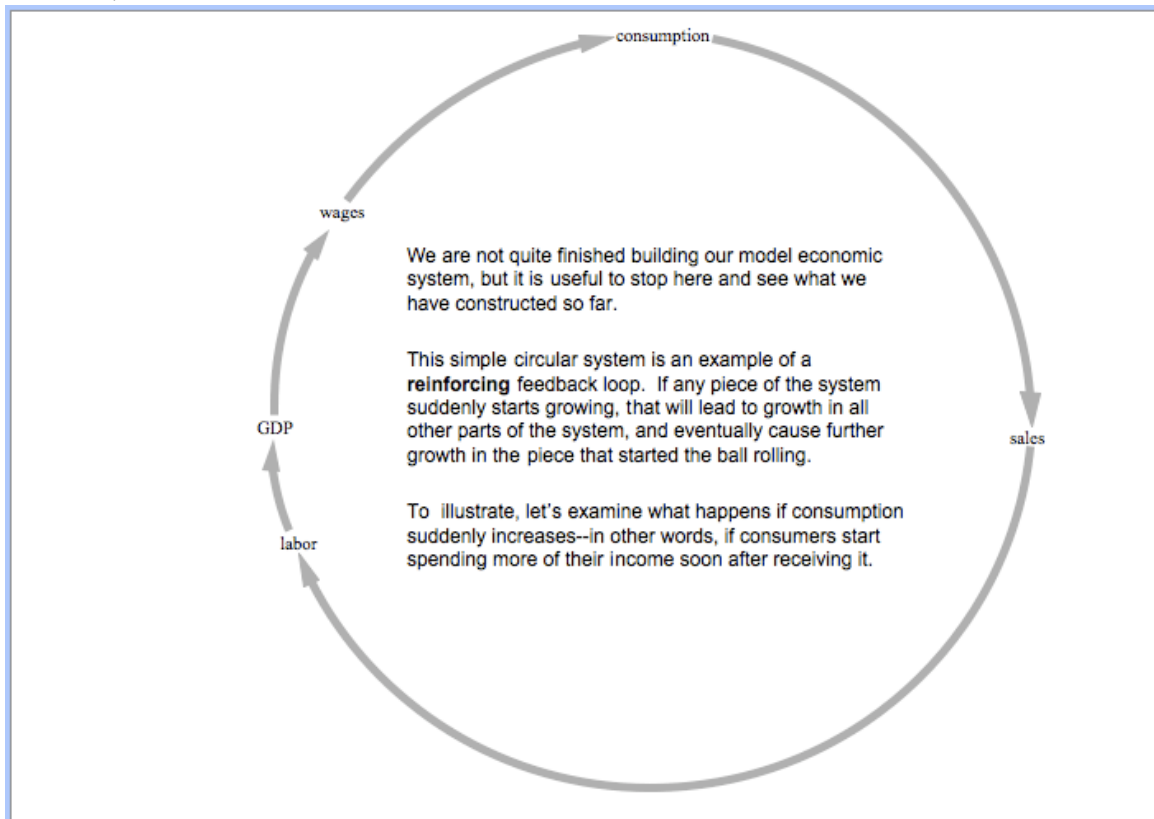
Slide 12, Method F:



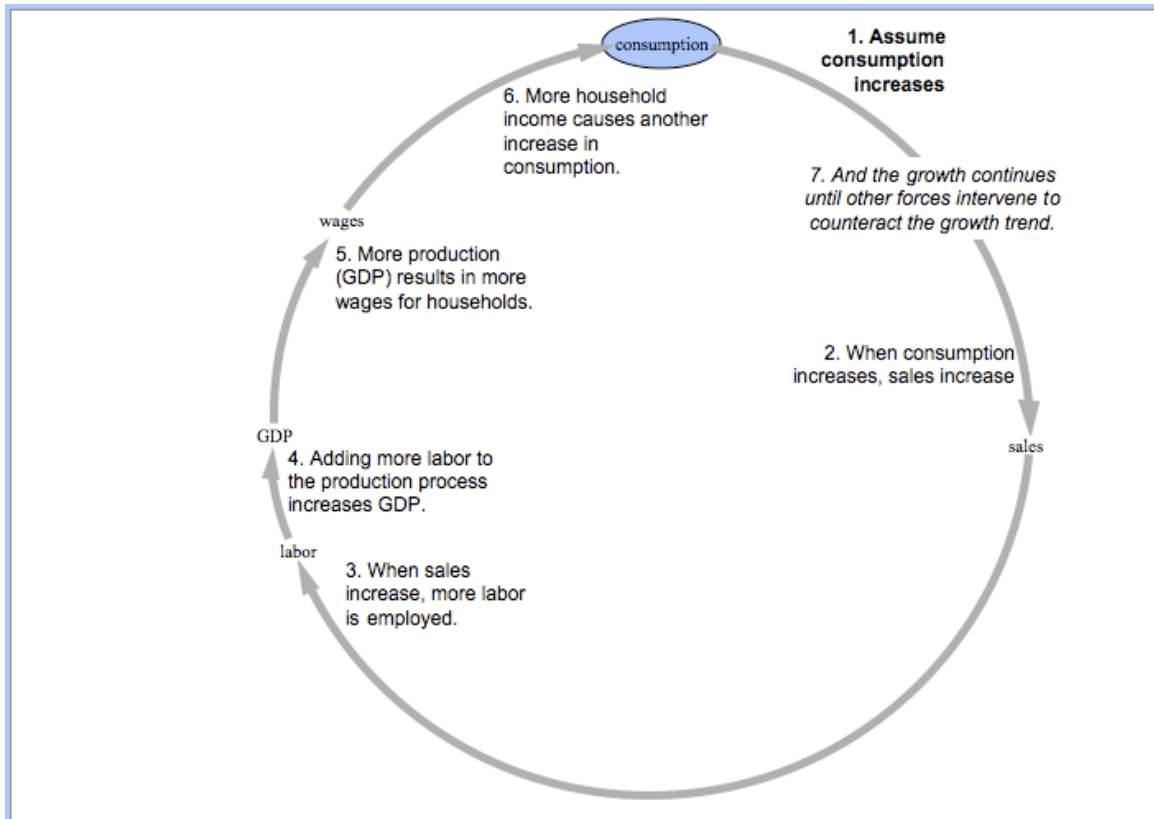
Slide 13, Method F:



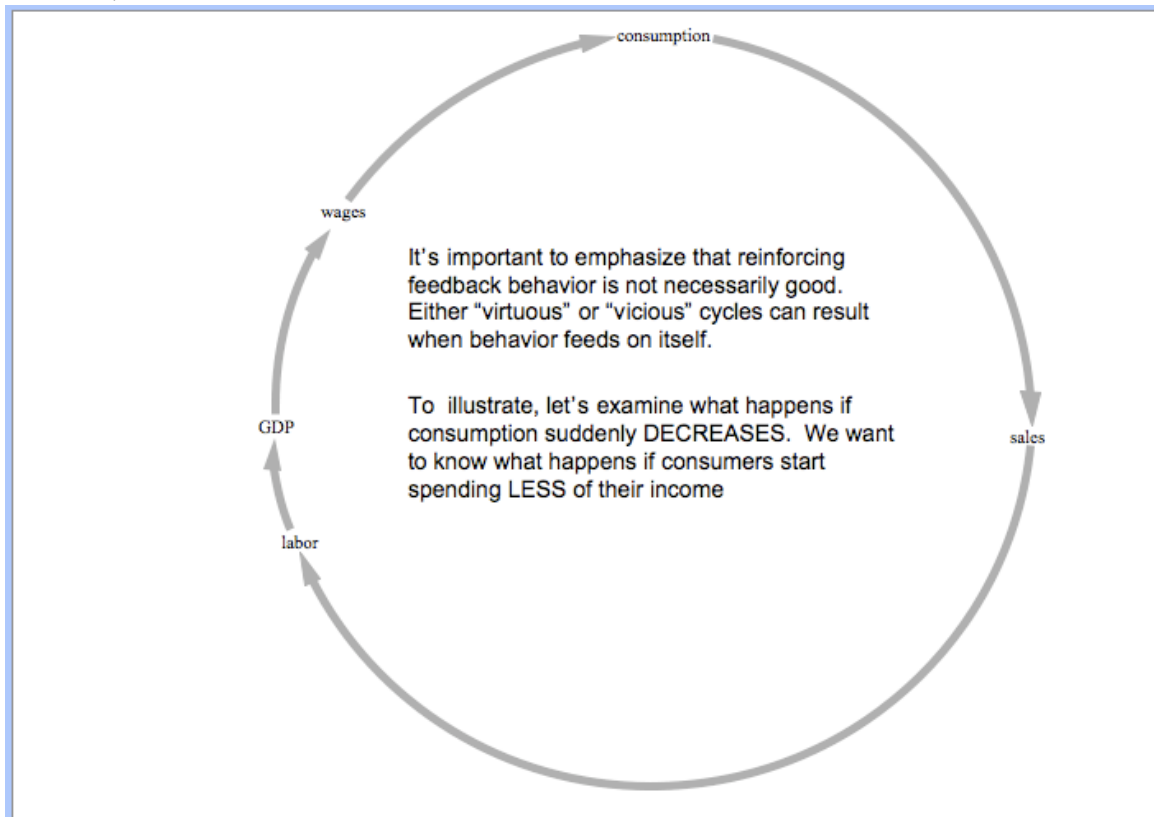
Slide 14, Method F:



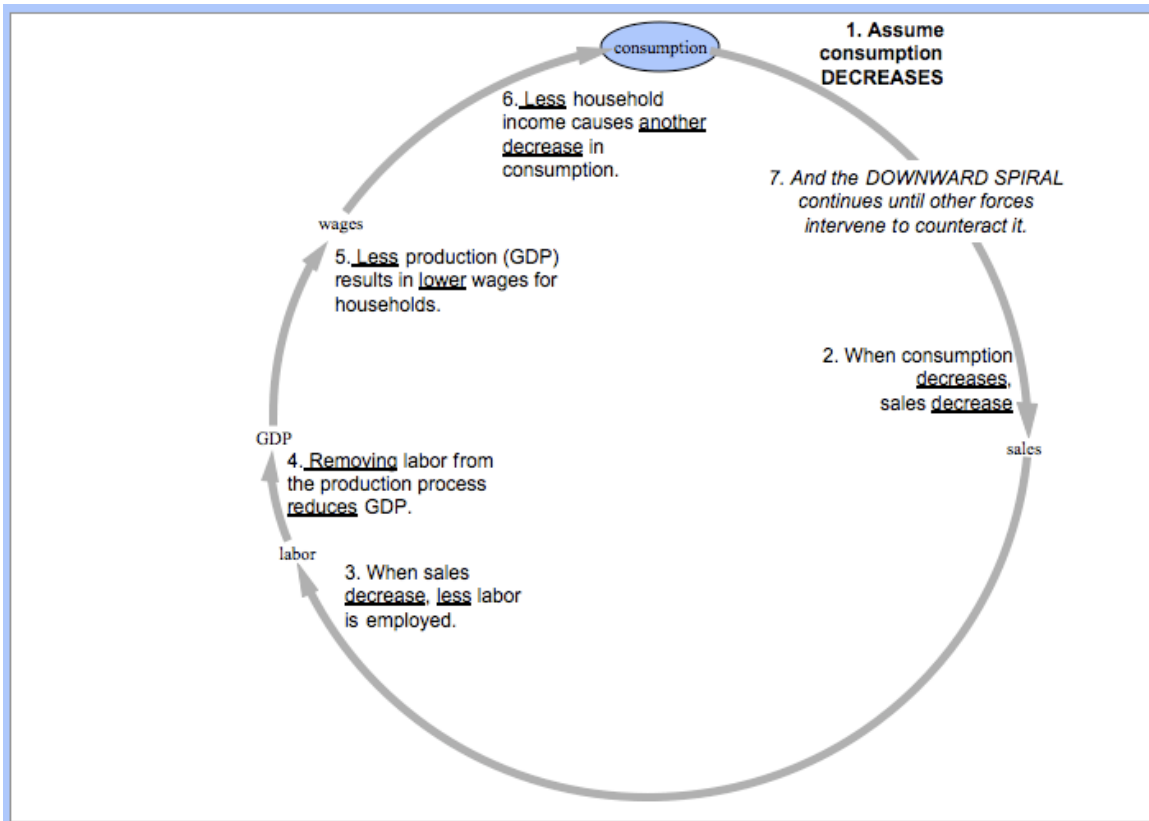
Slide 15, Method F:



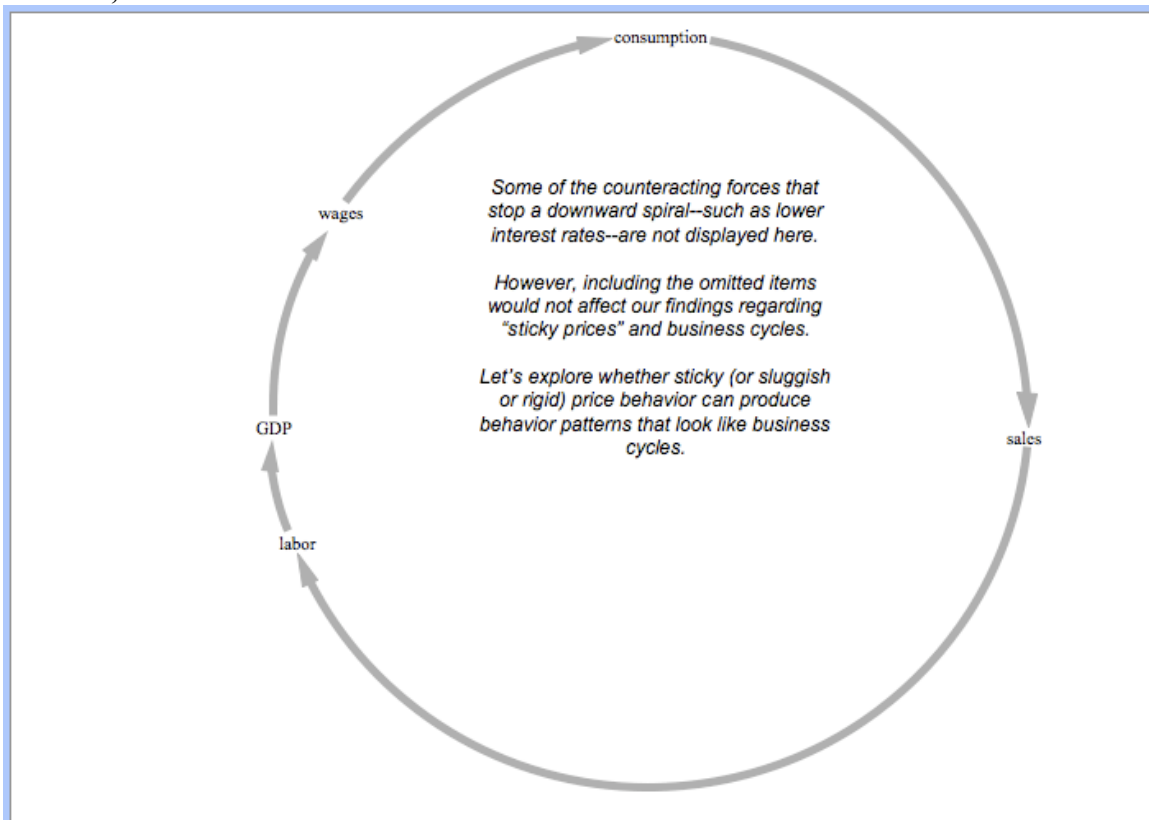
Slide 16, Method F:



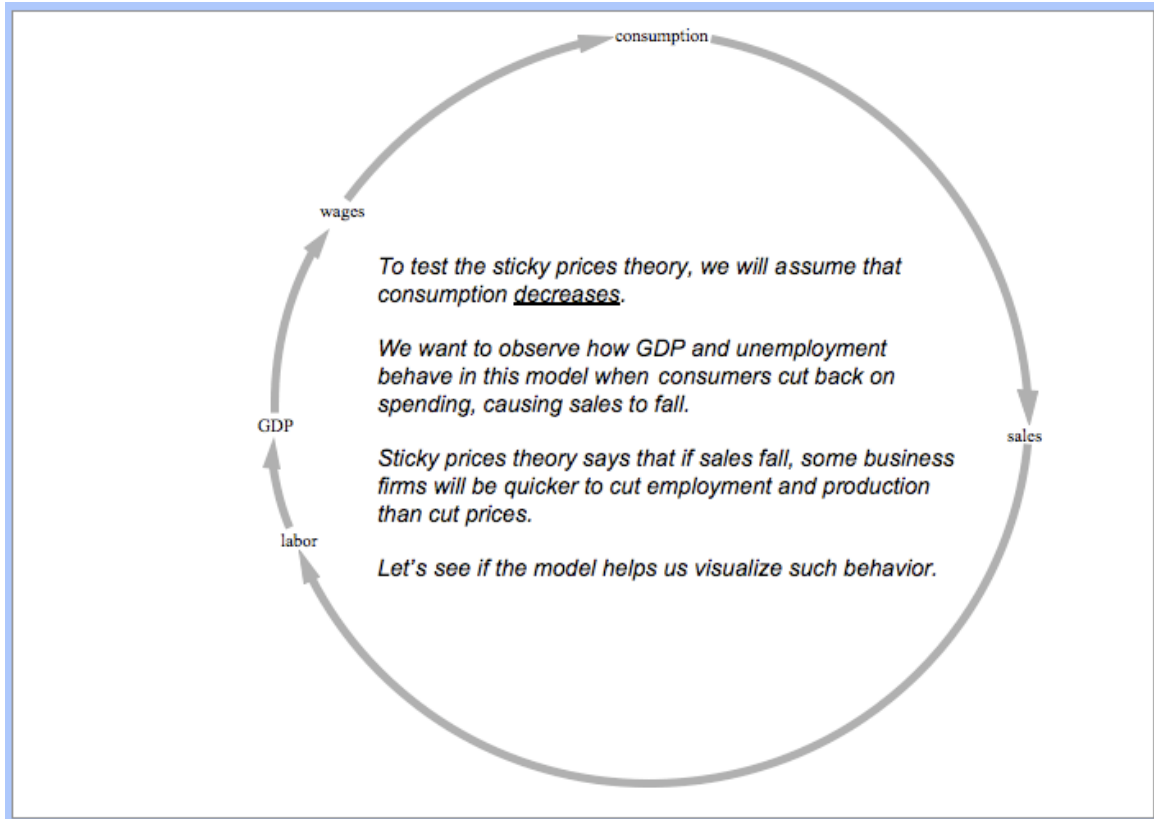
Slide 17, Method F:



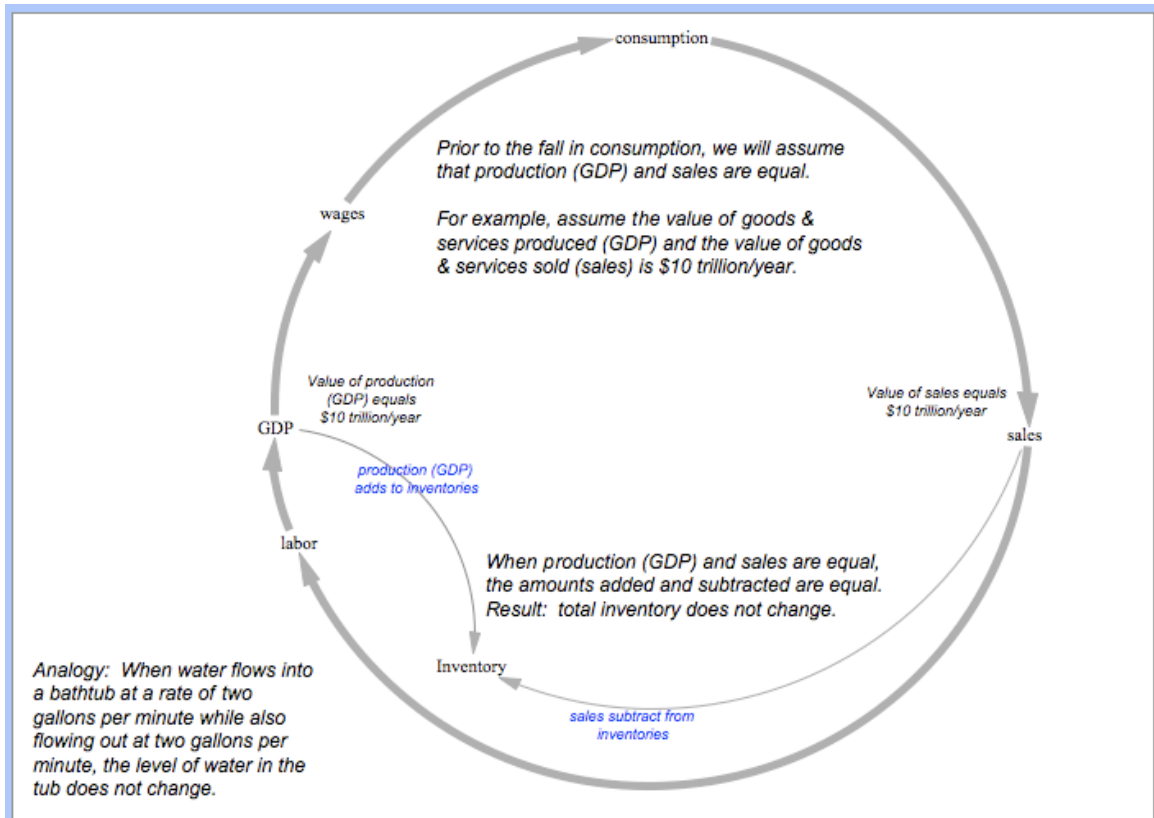
Slide 18, Method F:



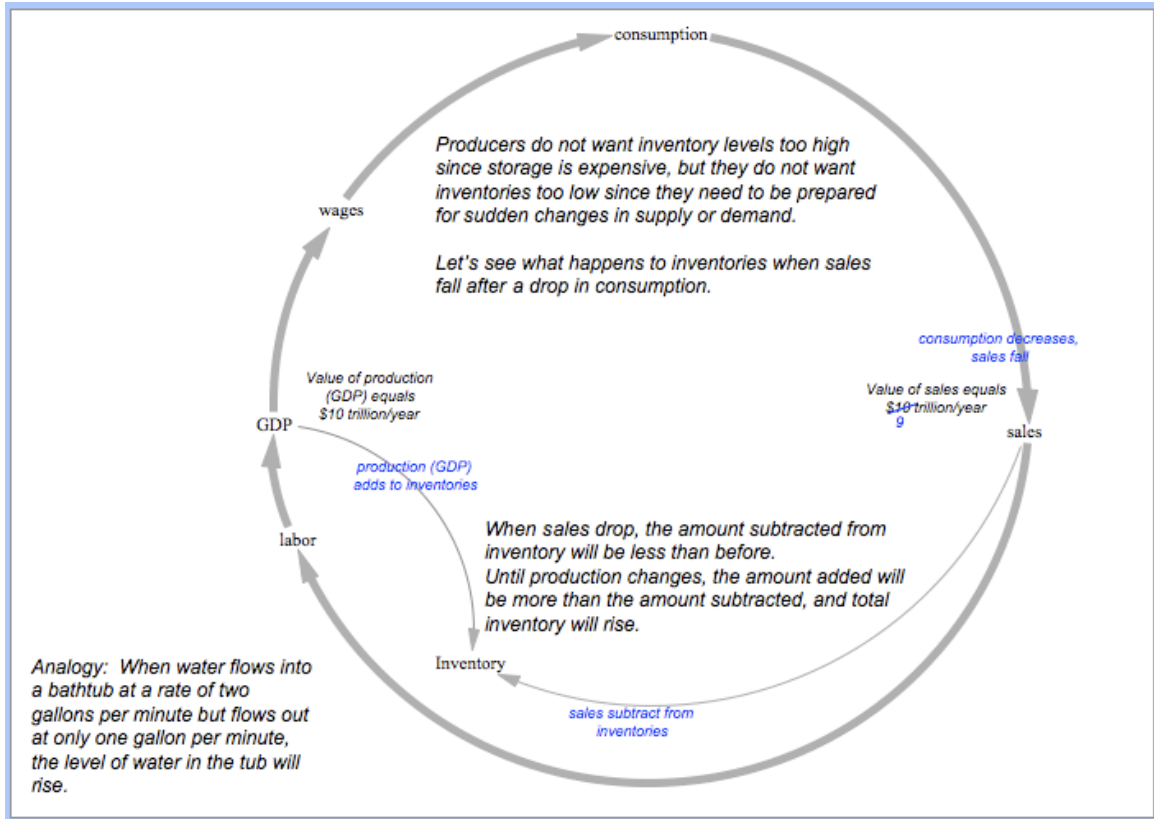
Slide 19, Method F:



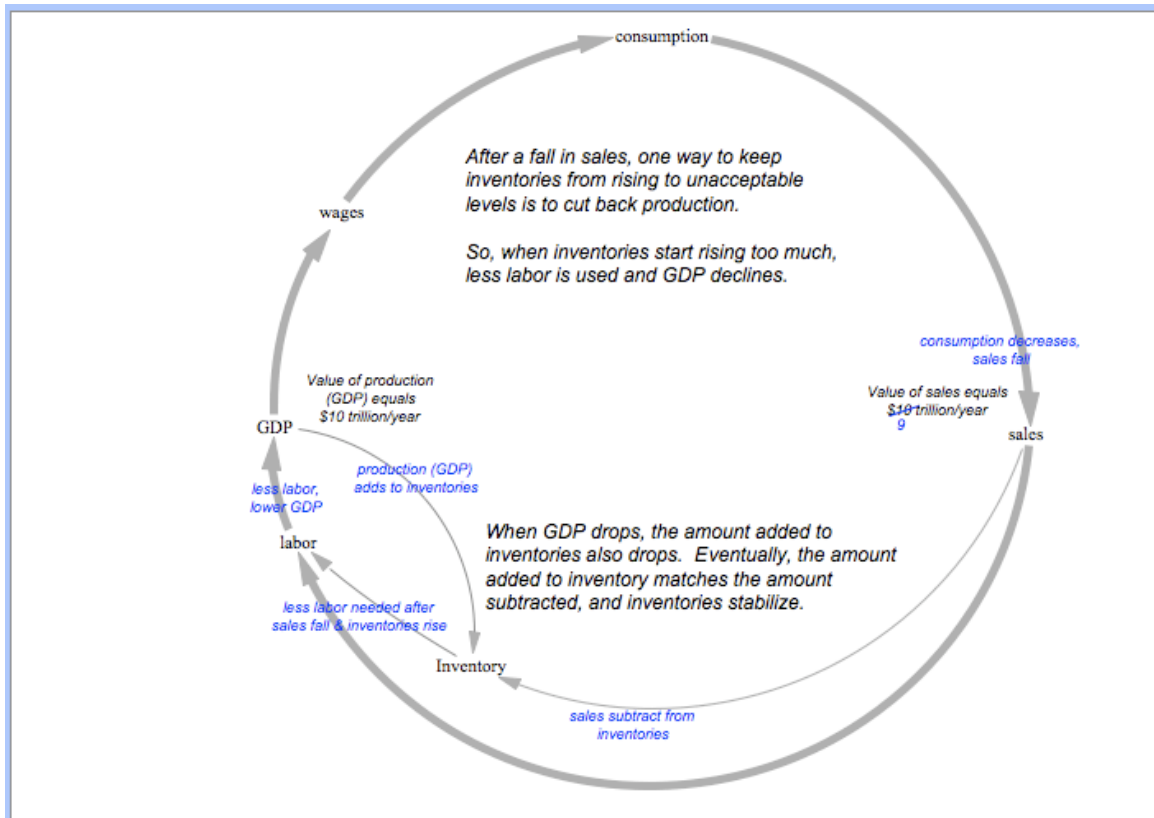
Slide 20, Method F:



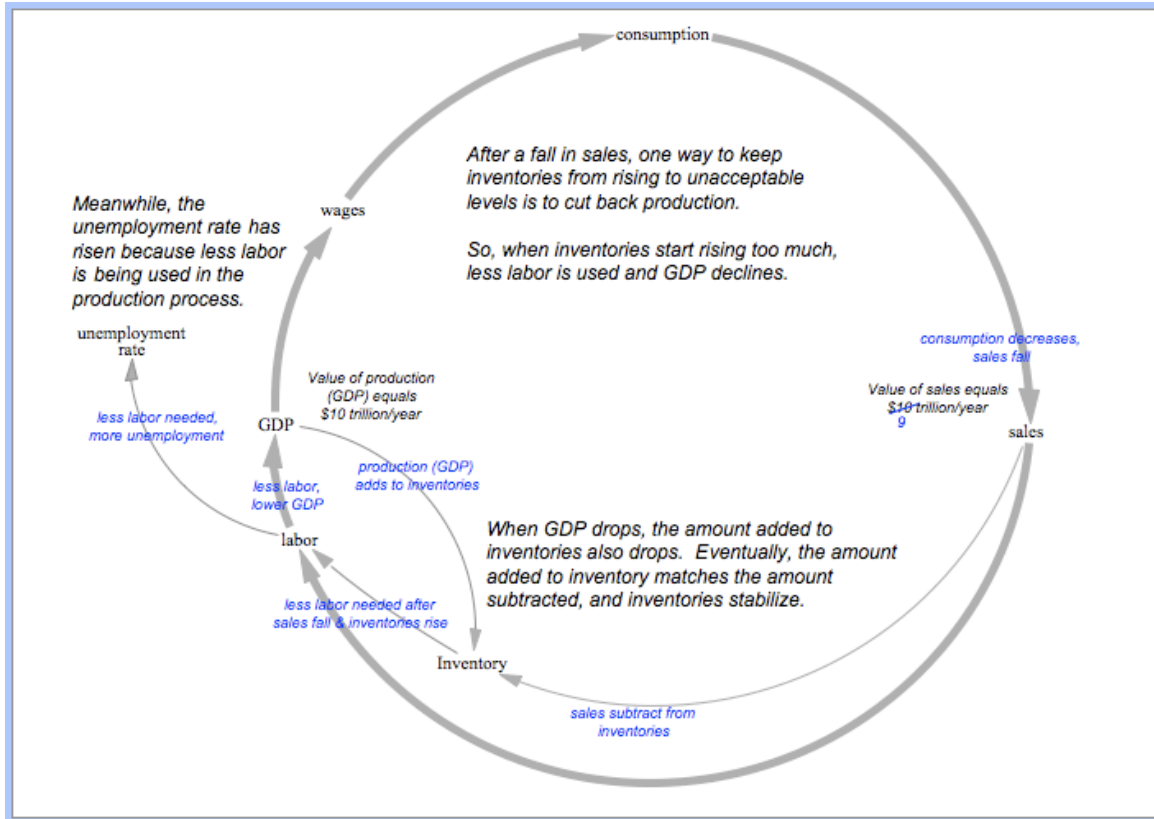
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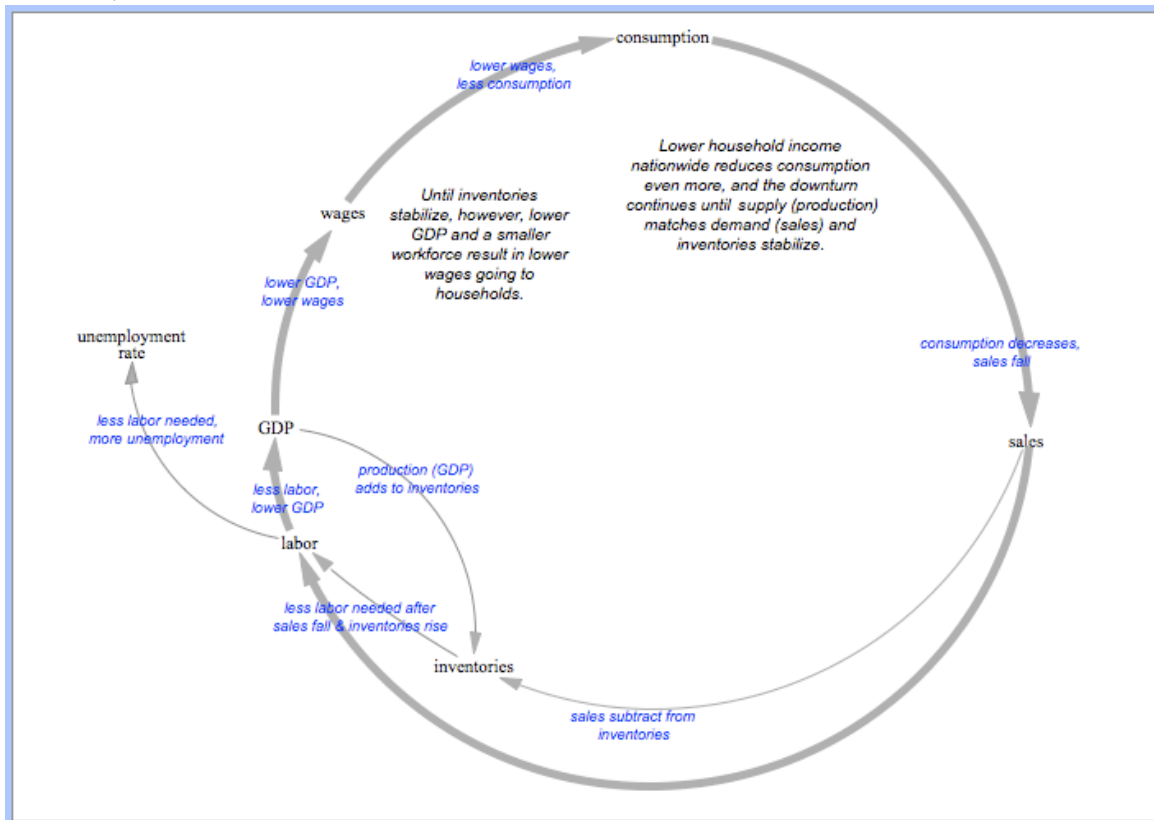
Slide 22, Method F:



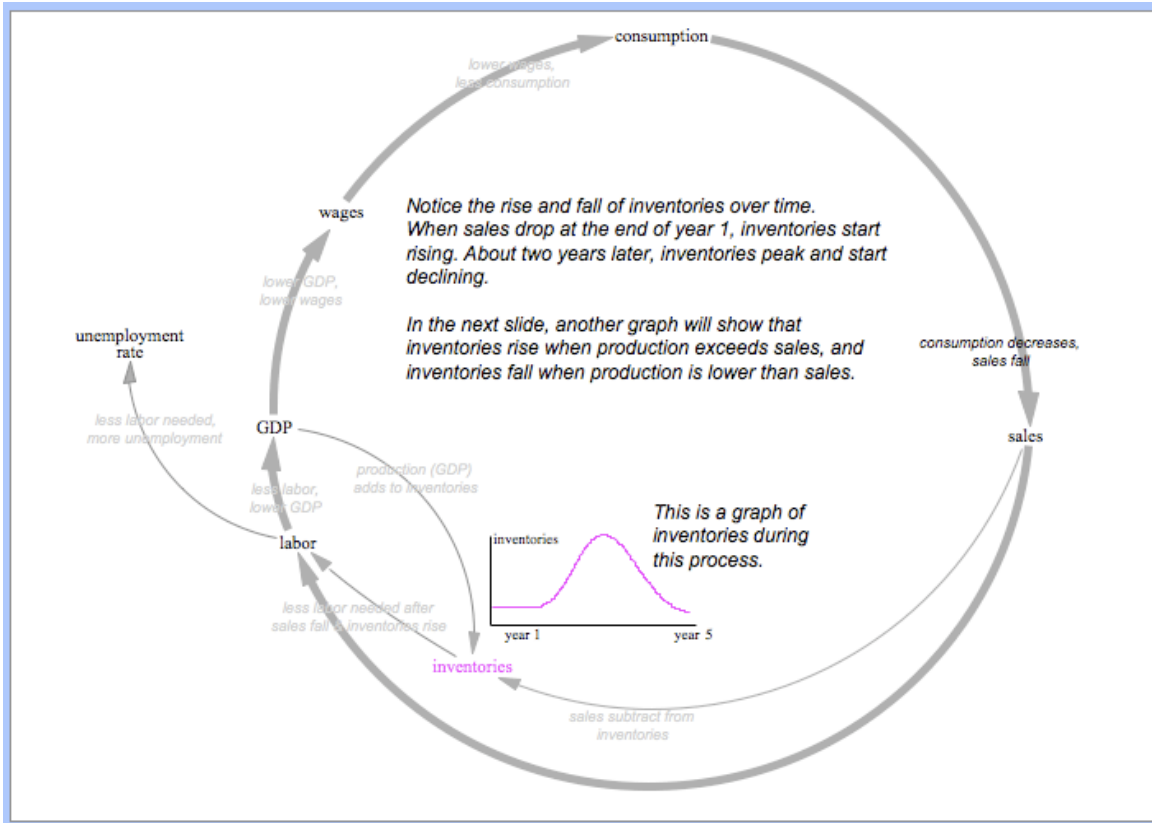
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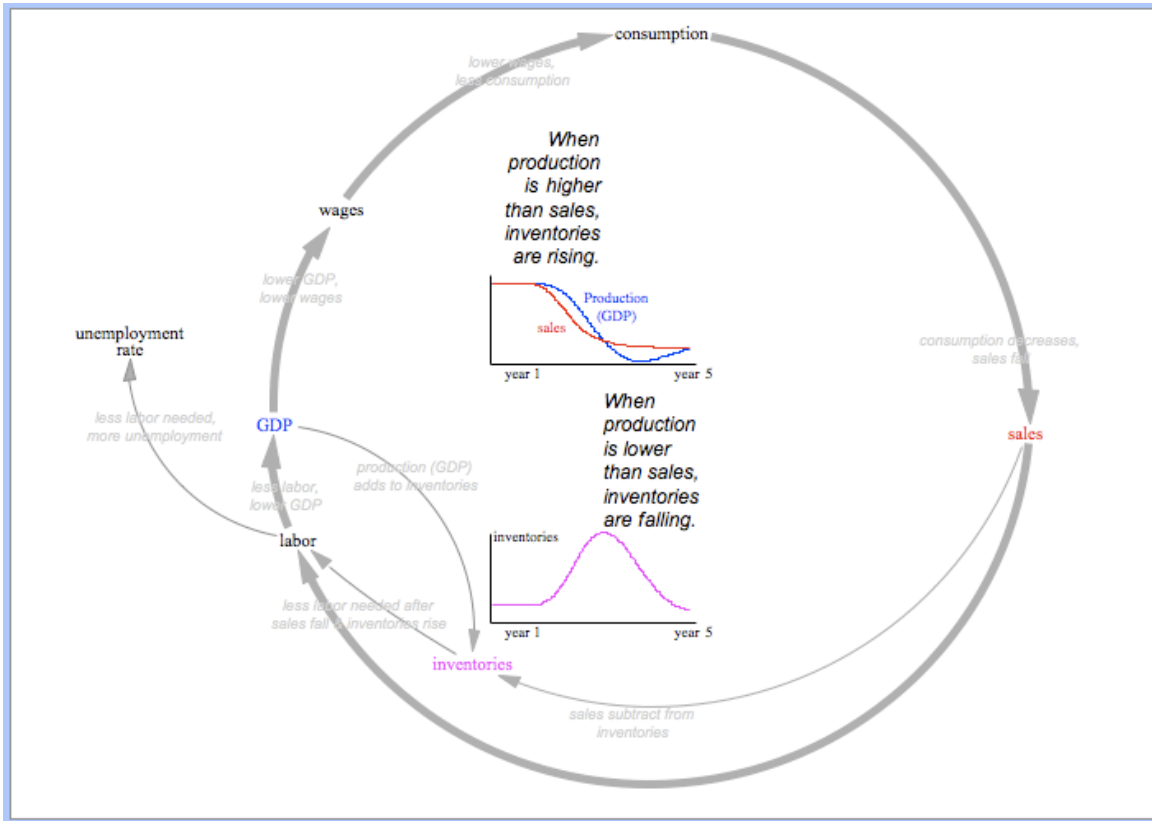
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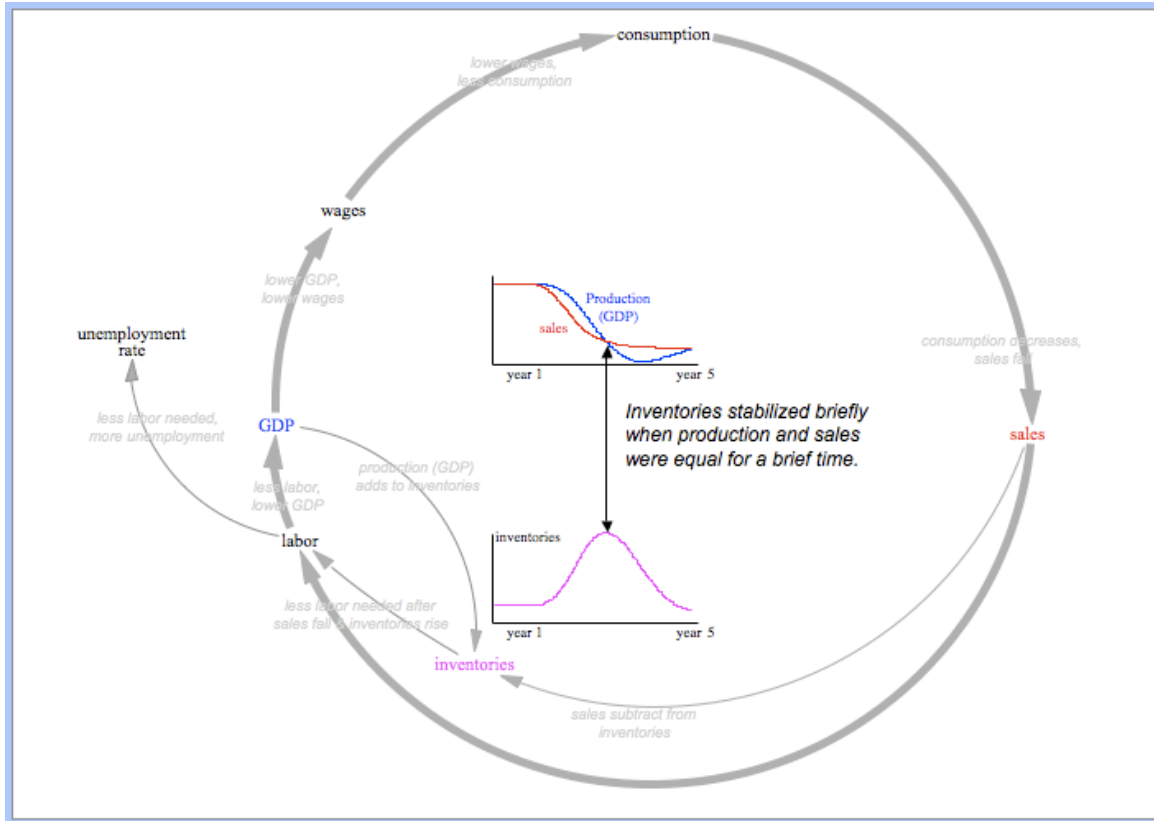
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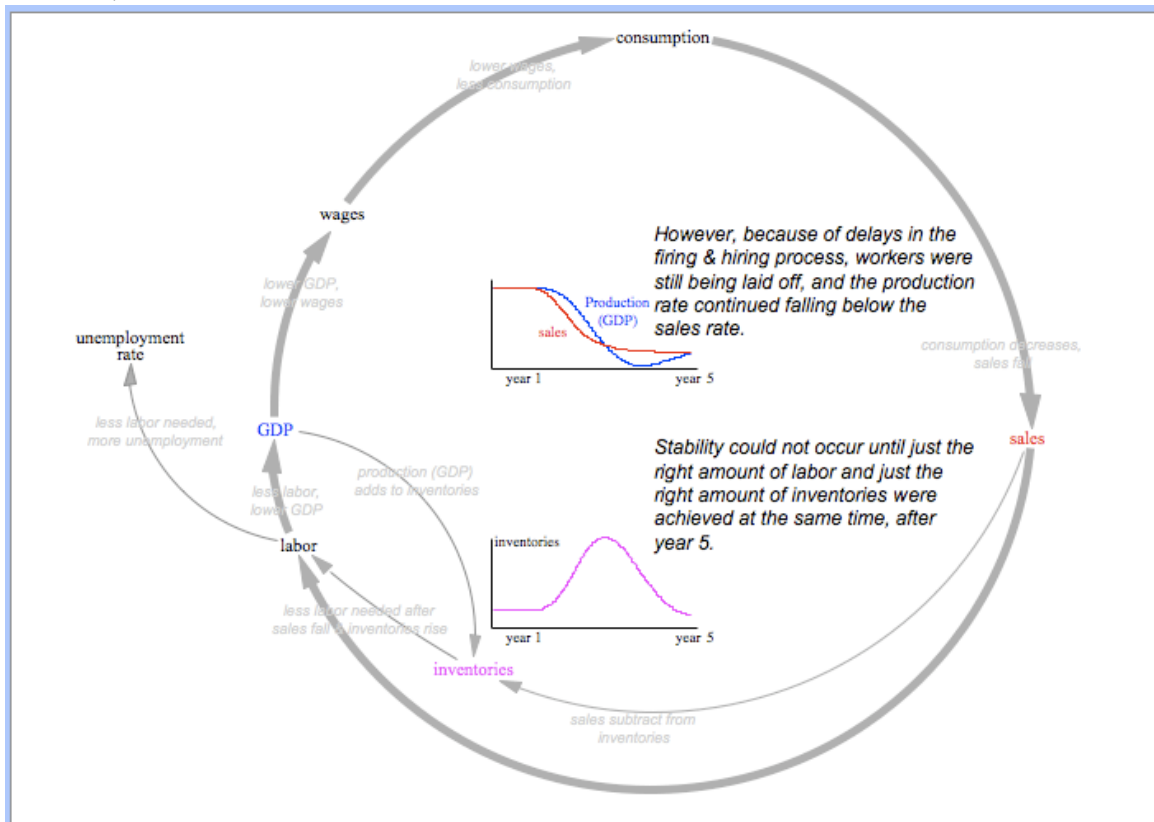
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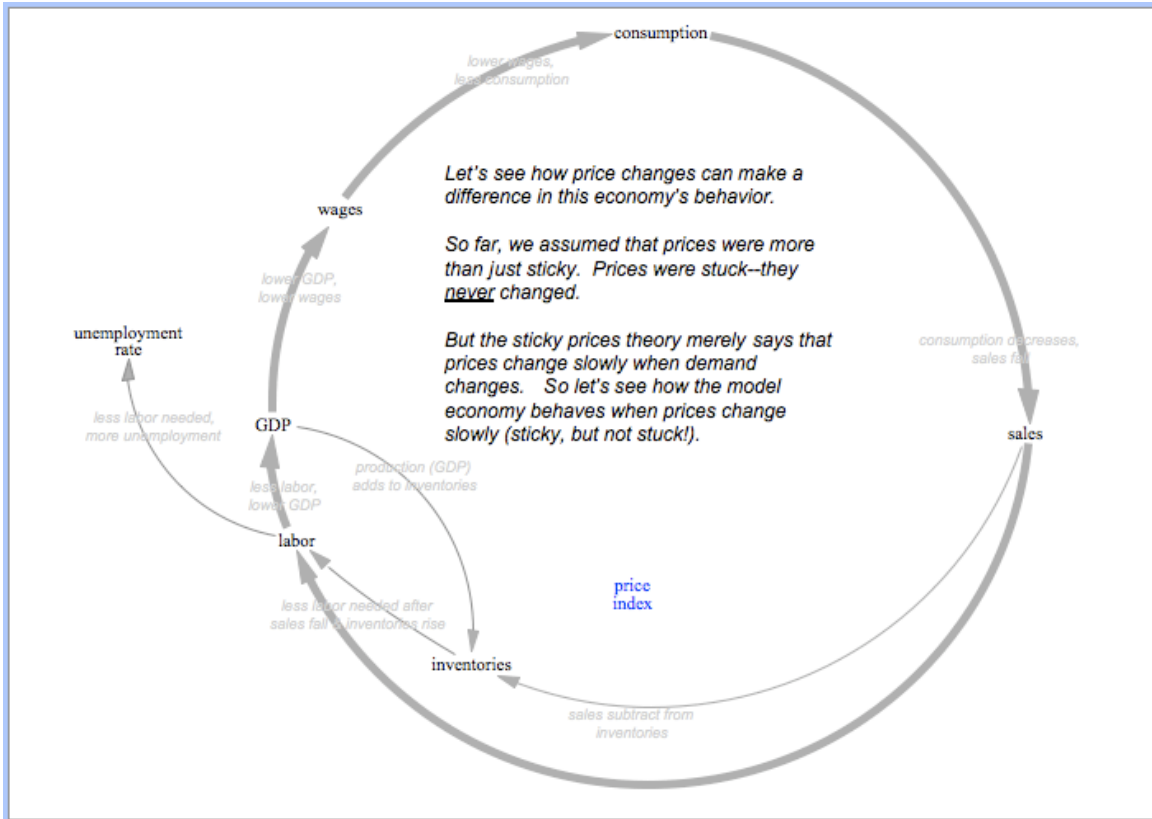
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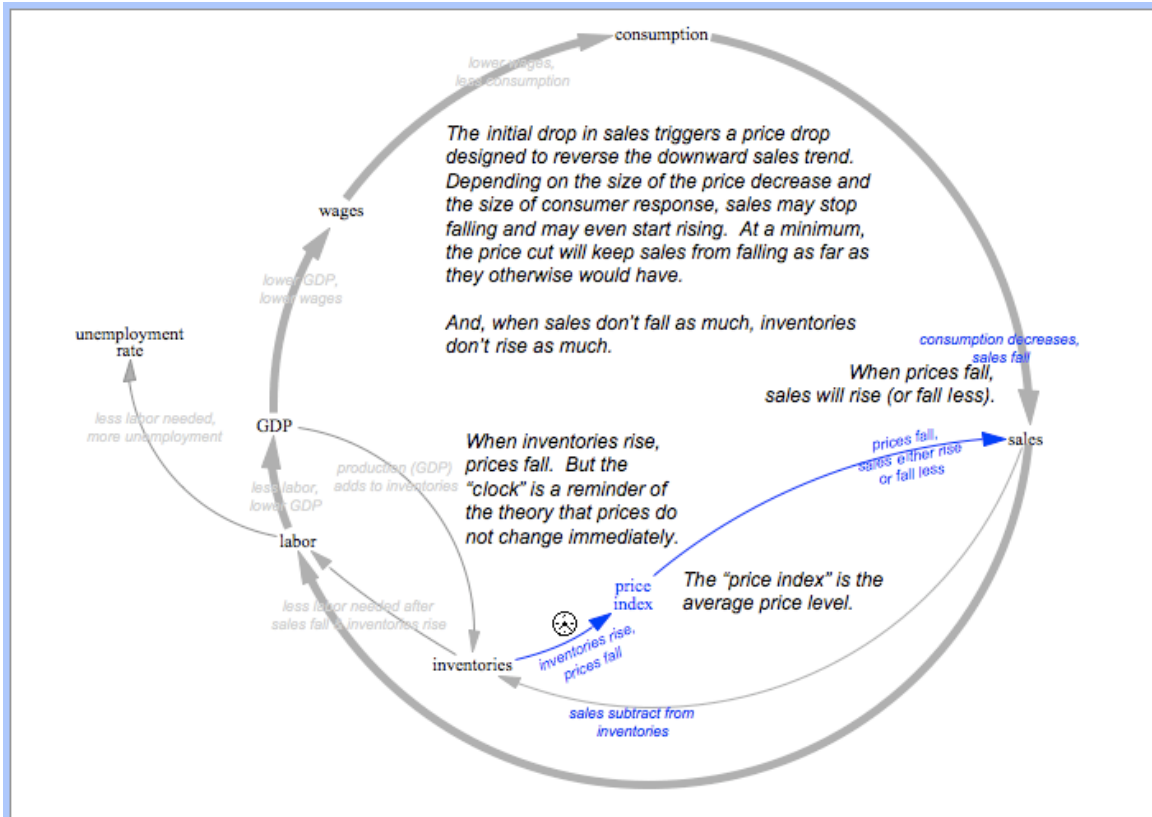
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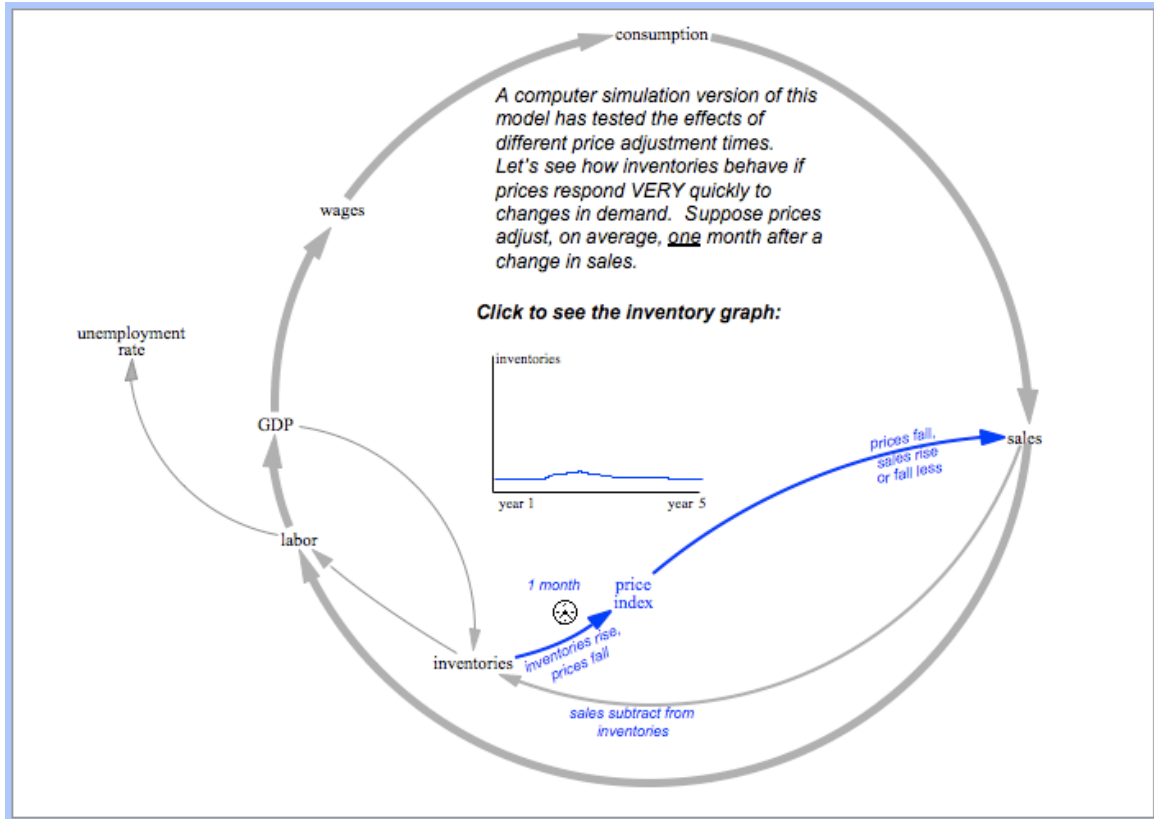
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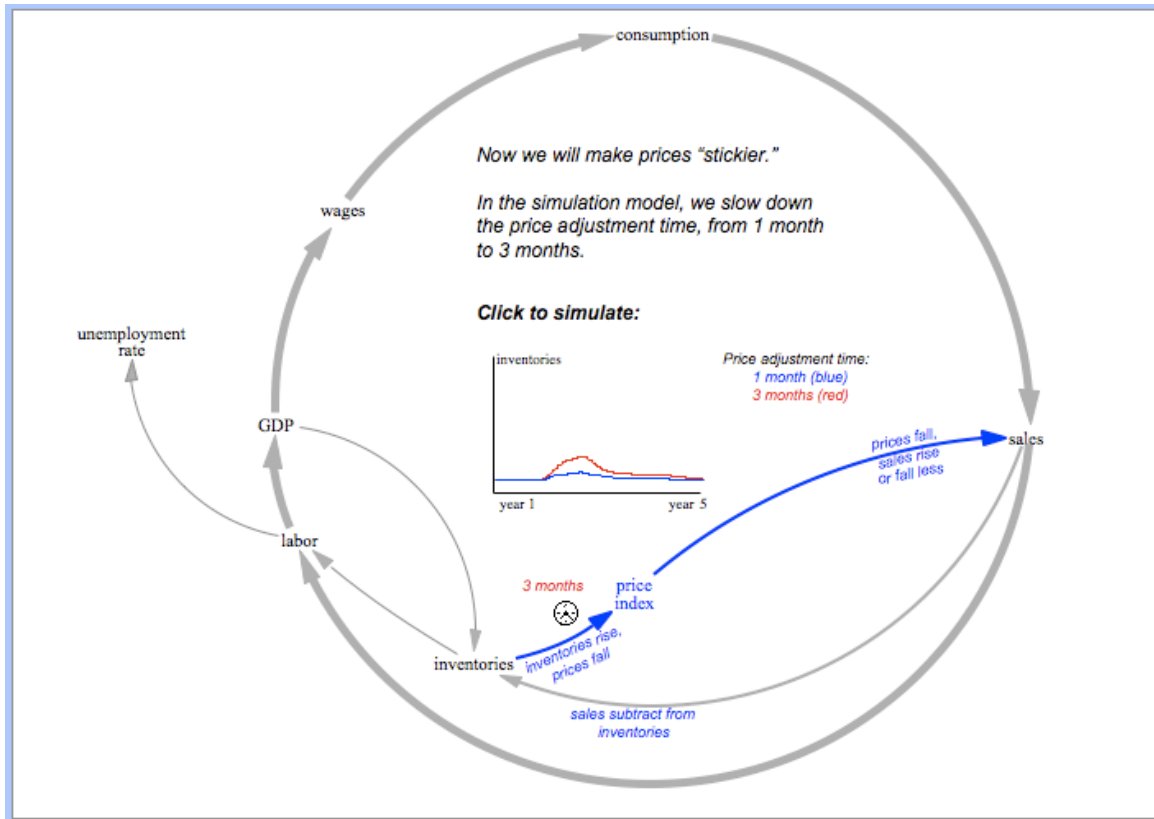
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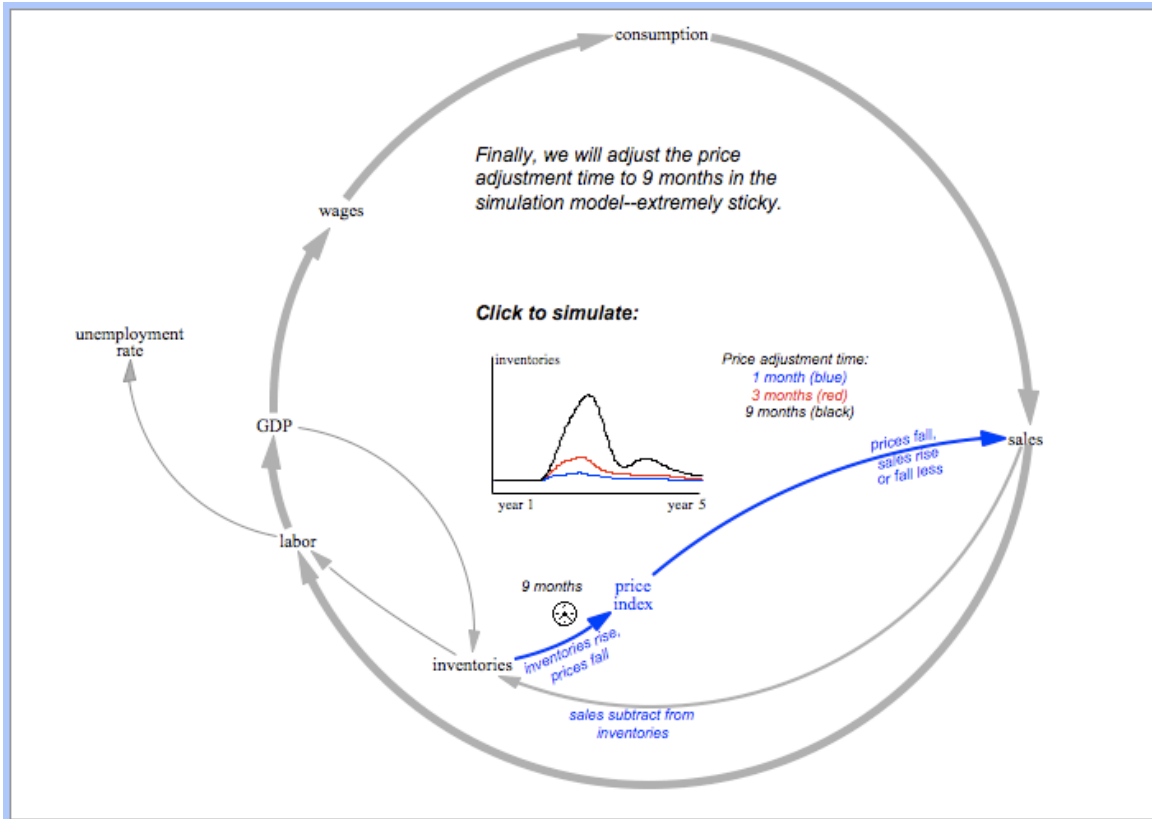
Slide 31, Method F:



Slide 32, Method F:



Slide 33, Method F:



Slide 34, Method F:

Simulating different degrees of "price stickiness" also affects GDP and unemployment, as illustrated in these graphs.

The result of a quick price response is shown in blue, where the price adjustment time was 1 month.

The result of adjusting prices in 3 months is shown in red.

The result of waiting 9-months to adjust prices is shown in black.

Click to simulate (three times).

GDP

year 1 year 5

unemployment rate

year 1 year 5

Appendix III. Data

Group A Student	-----First Round-----										-----Second Round-----									
	G-T1	G-T2	G-T3	G-T4	G-T5	G-T6	G-T7	G-E1	G-E2	G-T	F-T1	F-T2	F-T3	F-T4	F-T5	F-T6	F-T7	F-E1	F-E2	F-T
1.A	1	1	0	1	1	1	1	1	1	1	2	2	2	2	0	2	1	2	1	2
2.A	1	0	1	2	1	1	-1	2	1	1	1	1	1	1	2	1	1	2	1	2
3.A	2	1	2	2	2	2	2	1	1	1	1	1	1	2	2	2	2	1	1	2
4.A	1	1	2	0	1	1	0	2	1	1	1	1	2	0	1	1	1	2	1	1
5.A	1	1	2	1	0	1	1	2	1	0	1	1	2	2	1	2	2	2	2	2
6.A	1	0	1	2	1	1	1	2	1	1	1	1	2	1	1	2	1	2	1	1
7.A	1	2	1	0	2	1	1	2	1	1	2	2	2	2	2	2	2	2	2	2
8.A	1	-1	-1	-1	-1	-1	-1	-1	-2	-1	1	2	2	2	1	2	2	2	1	2
9.A	1	2	2	2	1	2	2	-1	-2	0	2	1	2	2	2	2	2	2	0	0
10.A	-1	-1	-1	-1	0	-1	0	-1	-1	0	2	2	2	2	2	2	2	2	1	1
11.A	2	2	2	0	1	2	2	0	0	1	2	2	2	2	2	2	2	2	2	2
12.A	1	1	1	0	1	1	1	2	0	0	1	1	2	2	1	2	2	1	1	1
13.A	-1	-1	-1	-1	-1	-1	-1	-1	-1	1	2	2	2	2	2	2	1	2	1	1
14.A	2	2	2	1	2	1	1	2	1	2	2	2	2	2	1	2	2	1	1	1
15.A	2	2	2	2	1	2	2	0	0	1	1	1	2	2	1	1	1	1	0	1
16.A	0	1	1	1	1	1	-1	-1	1	0	1	2	2	1	1	0	1	2	1	0
17.A	1	0	1	2	1	1	1	2	2	1	1	1	2	1	2	1	2	2	2	1
18.A	2	2	2	0	0	1	-1	2	1	-1	2	2	2	2	1	2	2	2	2	-1
19.A	1	0	1	0	1	1	1	0	0	1	2	1	1	1	1	1	1	1	1	1

Group B Student	-----Second Round-----										-----First Round-----									
	G-T1	G-T2	G-T3	G-T4	G-T5	G-T6	G-T7	G-E1	G-E2	G-T	F-T1	F-T2	F-T3	F-T4	F-T5	F-T6	F-T7	F-E1	F-E2	F-T
1.B	2	2	2	1	2	1	2	2	1	1	1	2	2	2	2	1	2	2	2	0
2.B	0	0	0	0	0	0	0	-1	-1	0	2	2	2	2	2	2	2	1	1	0
3.B	1	1	1	0	1	1	1	-1	0	0	2	1	2	0	1	1	1	2	1	1
4.B	1	0	1	2	1	2	1	1	1	2	1	1	2	2	2	1	2	1	2	2
5.B	1	1	1	0	1	0	0	0	0	0	1	1	1	1	1	1	1	1	0	1
6.B	2	2	2	2	1	1	2	1	1	2	2	2	2	2	2	2	2	2	2	2
7.B	0	0	0	0	0	0	0	-1	-1	-1	1	0	1	0	1	0	0	1	1	1
8.B	1	0	1	1	2	0	0	1	0	1	1	2	1	1	1	0	1	1	0	0
9.B	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	2	2	2	1	2	1	1	2	1	2
10.B	-1	-1	-1	-1	-1	-1	-1	-2	-2	-2	2	2	2	2	2	2	2	2	1	2
11.B	1	1	1	0	1	1	1	1	0	2	1	1	1	2	1	1	2	1	0	2
12.B	0	1	1	0	0	0	0	-1	-1	0	1	1	1	0	1	0	1	1	0	1
13.B	2	2	2	2	2	2	2	1	1	2	2	2	2	2	2	2	2	1	1	1
14.B	1	0	1	1	1	0	-1	-1	-2	0	1	1	1	2	2	1	1	2	0	0
15.B	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	-1	1	0	1
16.B	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0
17.B	1	1	1	0	0	0	0	-1	-1	0	2	2	2	2	1	2	1	2	2	2
18.B	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	1	2	2	1	0

See Figure 9 for statement wording of T1-T7 and E1-E2. See *Postscript*, p. 3-11, for statement wording of T.

Group A students received the graphical (G) instructional treatment during the first round of instruction, followed by the feedback loop (F) method in the second round. The reverse sequence was followed by the students in group B.

Response categories were *strongly agree*, *agree*, *unsure*, *disagree*, and *strongly disagree*. Arbitrary values of 2, 1, 0, -1, -2 were assigned to those responses, respectively.