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WHAT CAUSED THE RECESSION OF 2008? HINTS FROM LABOR PRODUCTIVITY

Casey Mulligan

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ABSTRACT

A labor market tautology says that any change in labor usage can be decomposed into a movement along a marginal productivity schedule and a shift of the schedule. I calculate this decomposition for the recession of 2008, assuming an aggregate Cobb-Douglas marginal productivity schedule, and find that all of the decline in employment and hours since December 2007 is a movement along the schedule. This finding suggests that a reduction in labor supply and/or an increase in labor market distortions are major factors in the 2008 recession. The decline in aggregate consumption suggests that the reduction in labor supply (if any) is neither a wealth nor an intertemporal substitution effect. "Sticky real wages" or the emergence of significant work disincentives are possible explanations for these findings.

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Financial market chaos has been the main story of 2008, and at roughly the same time employment and hours have been falling. Both the public and academics have clamored for government action to alleviate the recession. But identifying the proper policy response likely requires an understanding of the causes and mechanisms by which the 2008 recession occurred.

A variety of explanations have been offered for previous recessions: adverse productivity shocks (Kydland and Prescott, 1982), a surge in the demand for "liquidity" (Friedman and Schwartz, 1963; Lucas, 2008), a collapse in international trade (Crucini and Kahn, 1996), and a stock market crash are among them. Which, if any, of these explanations apply today? This paper begins an answer to the question by decomposing the 2008 employment reduction into three types of potential "causes": productivity shocks that reduce labor and productivity, wealth and intertemporal substitution effects that reduce labor and raise consumption, and labor distortions and labor preferences that raise productivity and reduce labor. I conclude that the 2008 recession, like the 2001 recession, is qualitatively different from previous severe recessions because productivity growth (adjusted for changes in the amount of labor employed) was normal while labor "supply" (defined more rigorously below) shifted to the left.

Analytically, my decomposition is most like that of Katz and Murphy (1992), who look at changes over time in the relative amounts and productivity of skilled and unskilled labor in order to determine the relative importance of supply and demand shocks. In terms of substance, this paper is about the changes over time in the overall *levels* of labor and labor productivity, which raises the possibilities of tax distortions, wealth effects, and intertemporal substitution effects that would be less important for understanding one education group's changes relative to another. In this regard, my

analysis is more like that of Chari et al (2007), who also consider capital market fluctuations and total factor productivity. Gali et al (2003), Mulligan (2002, 2005) are three other papers using the supply-demand decomposition to quantify labor market distortions over time; Hall (1997) uses it to quantify labor preference shifts.

Section I displays the basic time series used to make the decomposition: aggregate labor, consumption, and productivity per hour. Section II considers the degree to which productivity per hour changed due to shifts of the marginal productivity schedule, or movements along it. Section III considers the co-movements of labor and consumption in order to determine whether labor reductions were a wealth or intertemporal substitution effect (that would move consumption and leisure together) or some other shock to preferences or labor market distortions. Section IV compares these results to analogous calculations for previous recessions. Section V offers a possible reason why labor supply behavior might have changed: mortgage modifications that followed the housing market crash. Section VI concludes.

I. Monthly Indicators of Aggregate Economic Quantities

Figure 1 displays monthly measures of labor input since January 2007. The red and green series are civilian and nonfarm payroll employment, respectively, measured in thousands on the left axis (civilian employment is shifted by 7,000 in order to be displayed on the same axis with nonfarm payroll employees). The blue series is the aggregate hours index from the Bureau of Labor Statistics, which is a combination of numbers employed and weekly hours worked per employee. The labor input series seem to peak in December 2007, which is why the NBER dating committee declared December 2007 to be the beginning of the recession.

Figure 2 displays monthly measures of real per capita consumption since January 2007. Four of them are personal consumption expenditures and its major components from the national income accounts. The fifth is retail sales deflated by the deflator for personal consumption expenditures. The largest percentage changes are for durables and retail sales. Aside from spikes in May 2007, both series peak in the fall of 2007. Nondurables and overall personal consumption expenditures peak in May 2008.

Interestingly, all of the real PCE consumption measures increased in the last month of the sample.

Productivity has been rising during this recession. The usual indicator of hourly productivity (real output per work hour from the BLS) is measured quarterly, which has risen 2.7 percent over the past year, with increases in every single quarter.

II. Movements Along an Aggregate Marginal Productivity Schedule

II.A. Stability of the Marginal Productivity Schedule during the 2008 Recession

Let y_t denote output per hour in month t, and n_t denote aggregate labor input. Consider the definition:

$$y_t \equiv \left(\frac{A_t}{n_t} \right)^{0.3} \tag{1}$$

So far, equation (1) is just a definition of the residual A_t. If aggregate output were Cobb-Douglas in labor with elasticity 0.7, then the residual A_t would have the interpretation of shifts of the aggregate marginal productivity schedule (measured in the quantity dimension), such as those created by technical change, capital accumulation, or capital utilization.[2]

Figure 3 displays the calculation of the log of the residuals $\{A_t\}$ for 2007 Q3 through 2008 Q4.[3] Each date point in the Figure is the actual value of output per hour and aggregate hours reported by the Bureau of Labor Statistics, measured on a logarithmic scale with the origin normalized to be 2007 Q3. Two of the points have a straight line (with slope -0.3) drawn through it representing the marginal productivity schedule (1) applicable at that date. If (hypothetically), a single marginal productivity schedule applied at each date, then all of the data points would be on the same straight line with slope -0.3. In fact, each date is a different distance from any particular schedule, so the log productivity residual measures the horizontal distance from the 2007

[2] Recall that average and marginal productivity are proportional when production is Cobb-Douglas.
[3] For the purposes of illustration, Oct-Nov 2008 productivity is assumed to be the same as 2008 Q3.

Q3 schedule and the actual data. Algebraically, the log residual is the inverse of the definition (1).

$$\ln A_t \equiv \ln n_t + \frac{\ln y_t}{0.3} \tag{2}$$

To the extent that the schedule shown in Figure 3 is the aggregate marginal productivity schedule, changes in *A* measure the amount by which the schedule shifted over time. Since 2007 Q4, labor quantity has declined every quarter, and labor productivity has risen. However, Figure 3 shows that, if the productivity schedule had not shifted, labor productivity would have advanced only about one-third of what it actually did.

Figure 4 displays the quarterly measures of log labor input n_t and log residual A_t, relative to their values for 2007 Q3. Labor input is changing much more over time than is the residual. Under the marginal productivity interpretation of that residual, Figure 4 shows that most of the change in labor input over time is a change in labor supply or labor market distortions rather than a shift in the marginal productivity schedule. When viewed through the lens of *any* model in which aggregate output is a Cobb-Douglas function of labor input with elasticity 0.7, aggregate adverse productivity shocks do not seem to be an important impulse in this recession.

II.B. Marginal Productivity Shifts during Previous Recessions

Figures 5 and 6 display the change in the log productivity ($\ln y_t$) and log marginal productivity residual ($\ln A_t$) for the recessions of 1974, 1981, 1990, 2001, and 2008. For each recession, the productivity residual is shown relative to its value in the quarter prior to the NBER peak. Productivity normally increases in non-recession periods, although the amount has varied from decade to decade. Productivity also increased in the 2001 and 2008 recessions. More notable are the earlier three recessions shown in Figure 5 in which productivity declined (1970s and 1980s) or was pretty flat (1990s). As shown in Figure 6, productivity failed to increase during the three earlier recessions because of shifts of the marginal productivity schedule.

When viewed through the lens of a model in which aggregate output is a Cobb-Douglas function of labor input with elasticity 0.7, aggregate productivity shocks do not seem to be an important impulse in this recession or in the 2001 recession. But adverse productivity shocks were part of the impulses of the three earlier recessions.

III. Neither Wealth nor Intertemporal Substitution Explains the "Supply" Shift

III.A. Consumption and Leisure have Moved in Opposite Directions

In theory, movements along the marginal productivity schedule can occur for a variety of reasons: wealth effects, intertemporal substitution effects, preference changes, and labor market distortions are among them. The wealth effect explanation says that people work less because they feel richer. The intertemporal substitution effect says that people work less in 2008 because they view 2008 as a relatively bad time to work and produce income, either because the return to saving is low or because they expect future labor productivity to be even higher than it is now. Both the wealth and substitution effect theories imply that consumption is *high* during the recession (Barro and King, 1984).

Figure 2 easily rejects the wealth and intertemporal substitution effect explanations because consumption expenditure has been low in this recession. In other words, wealth and intertemporal substitution effects seem to be moving the economy down the marginal productivity schedule, and the net result is less labor, so something else must be moving the economy up the schedule even more.

III.B. A Labor Market Metric for Consumption Declines

Putting more structure on preferences for consumption and work permit me to quantify the size of the wealth and intertemporal substitution effects, and thereby the size of the leftward labor supply shift (or labor market distortion change) that would have occurred absent those effects. In particular, I assume that the month t marginal rate of substitution between consumption and leisure is proportional to the ratio of real consumption per person to leisure time per adult:

$$MRS_t \sim \frac{c_t / P_t}{1 - \frac{n_t}{TN_t}} \tag{3}$$

where c_t is aggregate real consumption of nondurables and services, P_t is population (adults and children), N_t is the adult population, n_t is total labor time, and T is the total available time of each adult.

Absent labor market distortions and other determinants of the marginal rate of substitution, the marginal rate of substitution would equal marginal labor productivity, which is itself equal to average productivity times labor's share (which I take to be 0.7). As explained by Mulligan (2005), changes in the gap between (3) and average productivity y_t are therefore measures of changes in the combined effect of changes in labor market distortions and other determinants of the marginal rate of substitution. Denoting that gap as $(1-\tau_t)$, its changes can be calculated as:

$$\Delta \ln(1-\tau_t) \equiv \left[\Delta \ln(c_t / P_t) - \Delta \ln\left(1 - \frac{n_t}{TN_t}\right) \right] - \Delta \ln y_t \tag{4}$$

In words, each percentage point that consumption declines is a percentage point that distortions must increase in order to explain a given path for labor and productivity.

With the data I have, I cannot determine whether the gap $(1-\tau_t)$ captures preferences or distortions. Henceforth, for the purposes of brevity, I refer to $-\ln(1-\tau_t)$ as "the labor market distortion."

IV. Labor Market Distortions During Recessions

Figure 7 graphs quarterly changes in the labor market distortion τ, together with its supply component (the square bracket term in equation (4)) and its productivity component y_t. For the purposes of Figure 7-9, the time endowment T is assumed to be

four times the amount of labor per adult in 2002.[4] Distortions increased throughout the recession. Prior to 2008 Q2, much of the increase can described as stable consumption and rising leisure in the face of rising productivity.[5] From Q2 to Q4, productivity continued to grow while consumption fell.

Figure 8 graphs quarterly changes in the MRS or "supply" term (the square bracket term in equation (4)) for each of the recessions. The measured MRS falls in all of the recessions, although little in 2001. The 2001 recession's distinction in this regard may not be a surprise given that productivity grew a lot in that recession. Figure 9 graphs monthly MRS changes for the same recessions, showing how the MRS change for the last six months of 2008 is one of the largest of all of the recessions.

Figure 10 graphs quarterly changes in the labor market distortion τ for each of the recessions. The 1970s and 1980s recessions had essentially no labor distortion change through the first three quarters. Through four quarters, 2008 and 2001 recessions had the largest changes of all of the recessions. The large MRS reduction through December 2008 in spite of the continued productivity growth is an expression of the key finding of this paper: the employment decline is associated with a reduction in labor supply or an increase in labor market distortions, rather than a reduction in the marginal product of labor.

The labor demand equation (1) and the labor supply equation (4) can be used to simulate the equilibrium labor and labor productivity if labor distortions and the labor supply function had remained unchanged since the beginning of each recession yet consumption, population, and the labor demand residual had followed their actual values. For example, aggregate labor actually fell 0.027 log points 2007 Q3 through 2008 Q4 while the supply shift term $\ln(1-\tau)$ fell 0.049 log points. If instead labor had *risen* 0.050 log points, the distortion term would have been constant over time and log average productivity would have been essentially unchanged (specifically, 0.004 log points). In other words, the labor supply distortion not only prevented an increase in labor that

[4] 2002 is the benchmark year for the BLS aggregrate hours index.
[5] "Leisure" refers to adult time not spent working.

would have been consistent with the consumption drop, but actually reduced labor.[6] In this sense, the labor supply distortion is responsible for more than 100% of the employment decline since December 2007.

V. Mortgage Modifications and Other Means-Tested Benefits: Possible Sources of Reduced Labor Supply

Both labor and consumption have fallen in this recession even while productivity rose. As shown in Figure 10, the labor distortion – or labor supply shift – apparently emerging in the 2008 recession is on the order of five percentage points. What might have caused the marginal rate of substitution to fall even while the marginal product was rising?

One unique feature of this recession is that it was preceded by such a large reduction in home prices. About 12 million homes are now worth less than the mortgages owed on them. One way that mortgage lenders have responded to the loss in the market value of mortgage collateral is to partially forgive borrowers with low incomes.[7] In 2008, the Federal Deposit Insurance Corporation (FDIC), Federal National Mortgage Association (Fannie), and the Federal Home Loan Mortgage Corporation (Freddie) all announced debt forgiveness or "loan modification" formulas. The FDIC's plan says "Modifications would be designed to achieve sustainable payments at a 38 percent debt-to-income ratio of principal, interest, taxes, and insurance." (FDIC, 2008) Several major mortgage servicers such as Bank of America, JPMorgan Chase and Citigroup use those formulas for some of their delinquent borrowers. More recently, mortgage modification has become available for "homeowners who make their mortgage payments on time but who are struggling financially."[8]

[6] If 2008 Q4 real consumption per consumption per capita had been the same as in 2007 Q3, the productivity residual followed its actual values, and the labor supply distortion had not changed over time, then log labor would have increased 0.035 log points.

[7] Whether such forgiveness is in a bank's unilateral interest, or encouraged by regulators, is a topic considered by Mulligan (2008).

[8] http://www.usatoday.com/money/economy/housing/2008-12-11-foreclosures_N.htm

Much like banks use employment status and income as indicators for loan qualification, banks use employment status and income as indicators of "struggling financially." For example, Citigroup and the U.S. Treasury announced November 24th:

> "Citigroup will modify mortgages to help people avoid foreclosure along the lines of an FDIC plan that was put into effect at IndyMac Bank… struggling home borrowers pay interest rates of about three percent for five years. Rates are reduced so that borrowers aren't paying more than 38 percent of their pretax income on housing." (Aversa, 2008)

Consider a family with a mortgage that is underwater in the amount *b*, and anticipates the possibility of requesting mortgage modification early in 2009. The mortgage is expected to be modified so that it pays a constant housing payment for the years 2009-2014, after which time (for the purposes of illustration) the mortgage payments will return to their initial contractual level. The annual amounts of the payments for 2009-2014 are equal to 38 percent of 2008 family income, which the lender verifies by reviewing the family's 2008 tax return. Its budget constraint for leisure time versus the present value of all other goods (future leisure, future consumption, and current consumption) is shown in Figure 11. The point *X* is the amount of other goods that would be affordable if the family had no income in 2008 but paid its mortgage in full. At the point *Y*, the family is working enough, and thereby earning enough, that its full mortgage payment is exactly 38% of its income. Points on the straight line through *X* and *Y* are all possible choices for the family, assuming that they pay their mortgage in full.

The point *Z* is *b* dollars above the point *X*, and is thereby the allocation available to the family if it (a) defaulted on the mortgage, (b) did not earn income in 2008, and (c) did not bear any foreclosure or moving costs. If the lender forgave the amount *b* without conditions (and without foreclosure and moving costs), then the budget set would be bound by the dashed black line, rather than the solid one. Mortgage modification with the 38% formula offers the family the option of any of the allocations on the straight line between *Y* and *W*. YW has slope equal to the slope of XY times (0.38*R*-1), where *R* is the discount factor for a five year constant cash flow.[9] YW slopes up because reducing

[9] *R* is less than five, but likely greater than four. Thus, YW has a positive slope even though XY has a negative slope.

income by $1 in 2008 reduces bank payments by more than $1 in present value (namely, $0.38 per year for five years).

For each dollar that 2008 income is reduced from what it would be at *Y*, the lender is losing 0.38*R* compared to what it would get with full payment. As the choices along YW get closer and closer to point *W*, the lender's forgiveness approaches *b*. Once forgiveness has reached *b*, the lender might as well foreclose rather than forgive any more. Thus, the 38% formula implies that the family's budget constraint includes YWZX.[10]

Figure 11 is drawn for a relatively small value for *b*. However, if *b* were large enough that point *Z* had more consumption than point *Y*, the budget constraint would slope up over a wider range, as shown in Figure 12. In either case, there is a range of incomes were income is effectively taxed at rates in excess of 100%. One does not have to believe in elastic labor supply to strongly suspect that tax rates in excess of 100% would change behavior. The only unknown right now is how many people were had incomes in the relevant range and were aware of their modification opportunities.

Mortgage forgiveness is not the only work disincentive that has emerged during this recession. The Internal Revenue Service announced that it would be lenient with tax debts, but only for persons "struggling to pay their bills." According to the Associated Press (Ohlemacher, 2009),

> "It's unrealistic to expect some taxpayers to make timely payments in this economy, [IRS Commissioner Doug] Shulman said. However, he cautioned that those seeking help will have to demonstrate their inability to pay."

In other words, those who continue to earn will have to pay their taxes and IRS penalties in full. Those who have reduced earnings will not.

It is possible that an "economic stimulus" law will pass the U.S. Congress. This law may include tax breaks, spending plans, and further mortgage modification that conditions those items on a person's income (namely, those with low incomes will be eligible for more help than those with high incomes). When all of the instances of

[10] The lender may decide to foreclose before family income is as low as it is at *W*. In this case, some part of the triangle YWZ would be removed from the household's budget set.

means-tests are considered in combination, a number of workers in the U.S. economy may have a terrible incentive to work.

VI. Conclusions

Employment, hours, and consumption declined significantly in 2008, while labor productivity rose. I decomposed these changes into three types of "causes":

- productivity shocks that reduce labor and productivity,
- wealth and intertemporal substitution effects that reduce labor and raise consumption, and
- (unmeasured) labor distortions and labor preferences that raise productivity and reduce labor

It is well known (e.g., Barro and King, 1984; Hall, 1997) that previous business cycles do not appear to be wealth or intertemporal substitution effects because both labor and consumption decline. The 2008 recession is no different in this regard.

What is unique about the 2008 and 2001 recessions is the relative importance of productivity and unmeasured labor distortions. Figures 13 and 14 are scatter plots contrasting this recession and previous ones along these dimensions. Each recession is one data point in the chart. The horizontal axis measures the change in the log productivity residual from one quarter prior to the NBER peak to the second or fourth quarter following the NBER peak (Figures 13 and 14, respectively). The vertical axis measures the change in the unmeasured labor distortion (also in log points). The first three recessions each had productivity shifts that were less than experienced during non-recession years. The 2008 and 2001 recessions are unusual in that they have normal productivity shifts throughout, but have adverse labor distortion shocks. The 1970s and 1980s had much less increase in the labor distortion than did the other recessions.

The Great Depression of the 1930s was unique in its magnitude, and therefore not shown in Figures 13 and 14. Table 1 offers a comparison of the early 1930s to 2008. In this recession, the productivity residual has increased. The productivity residual *fell* more than 5 percent 1929-33 (Cole and Ohanian, 1999), which is many times more than it did in the 1970s and 1980s recessions. The labor distortion increased many times more than

it did even in 2008 (Mulligan, 2005). Although it is not clear whether the Great Depression was just an amplified version of the 1970s recession – with the labor distortion rising and productivity residual falling – it is qualitatively different from the 2008 recession.[11] The 2008 recession has not yet shown any adverse shift in the marginal product of labor schedule.

Admittedly it is unclear whether and how public policy can "fix" a recession. But even if we had a remedy for previous severe recessions, my finding that the 2008 recession is qualitatively different suggests that the proper remedy for this recession would also be qualitatively different.

VII. References

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[11] Cole and Ohanian (1999, Table 6) find total factor productivity to fall five percent in the first year of the Great Depression, and a total of 14 percent through four years. Mulligan (2005, Figure 4) finds the Great Depression labor supply distortion to increase 0.17 log points in the first year and 0.46 log points through four years. In other words, 1929-30 would be in the same quadrant of Figure 15 as the 1970s recession, and on about the same ray from the origin, but five times further away.

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Table 1. Residuals for the 2008 and the Great Depression

	residual changes (log points, in the price dimension)	
	productivity	**labor supply**
2007 Q3 - 2008 Q4	+0.019	0.049
1929-30	-0.053	0.17
1929-33	-0.15	0.46

Sources:
Cole and Ohanian (1999)
Mulligan (2005)

Fig 1. Aggregate Employment and Hours, Jan-07 - Dec-08

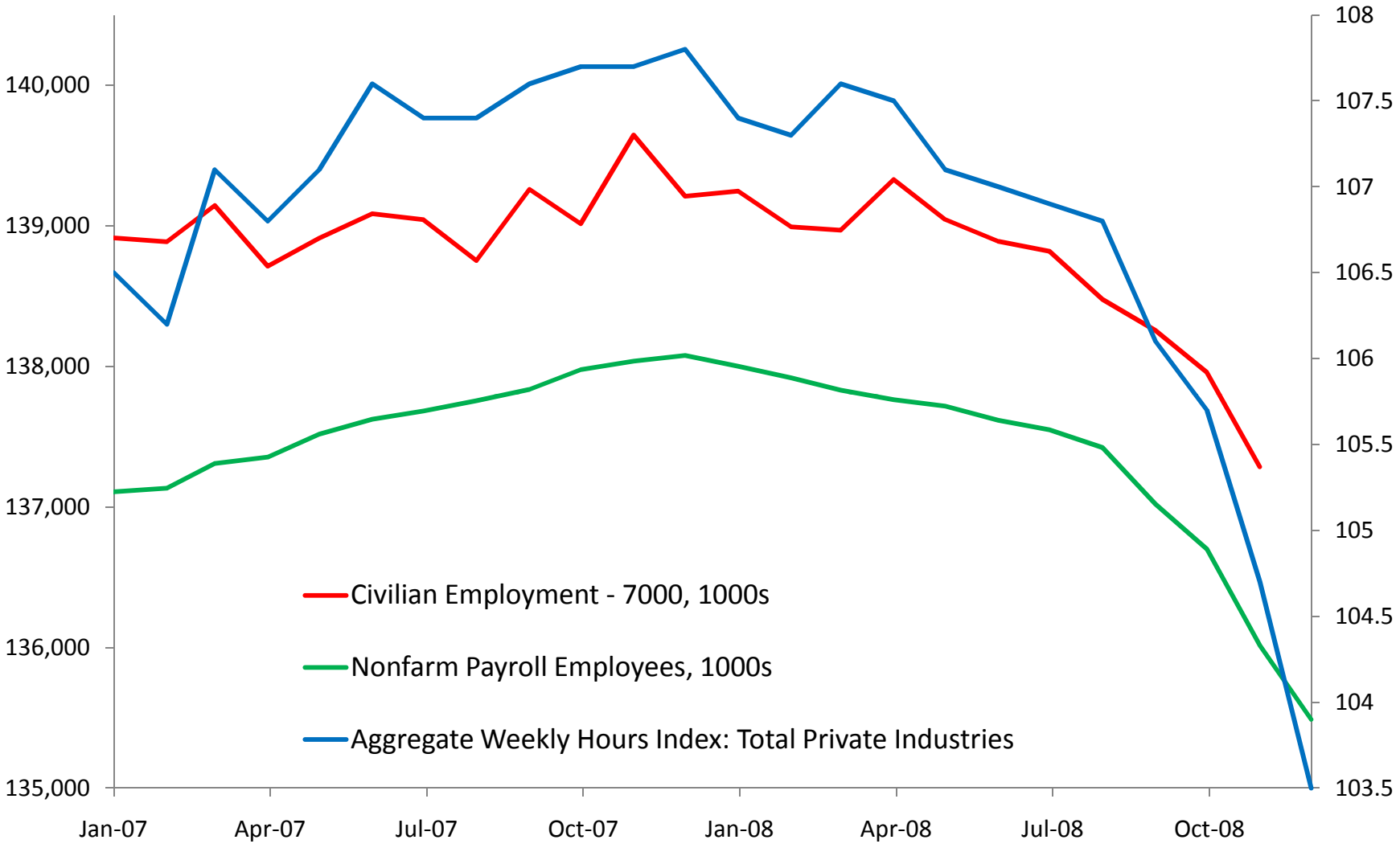


Fig 2. Real Per Capita Consumption, Jan-07 - Dec-08
(log change from Sep-07)

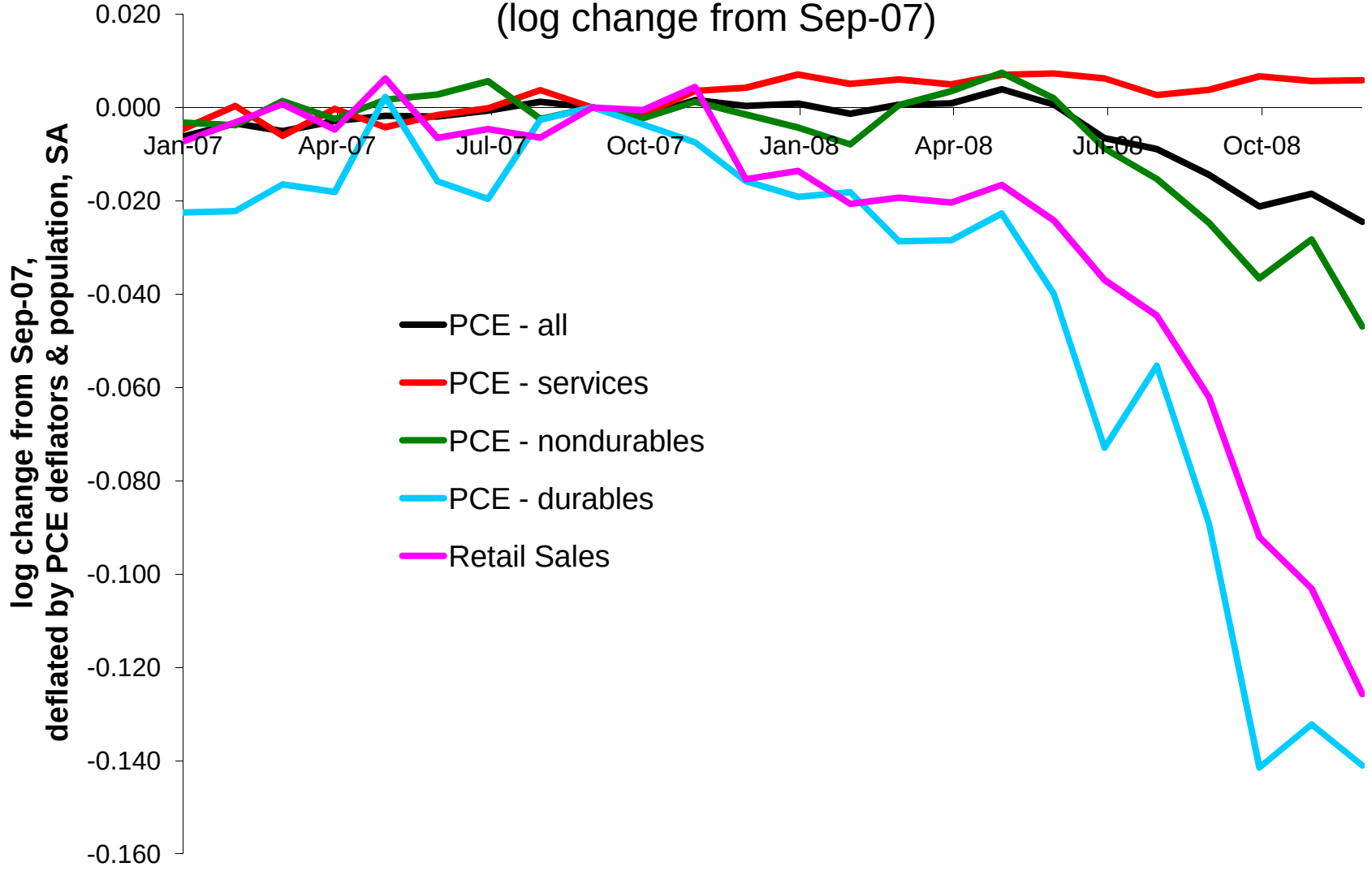


Fig 3. Marginal Productivity Schedules, 2007 Q3 - 2008 Q4

Fig 4. Labor and Productivity Residuals in the 2008 Recession

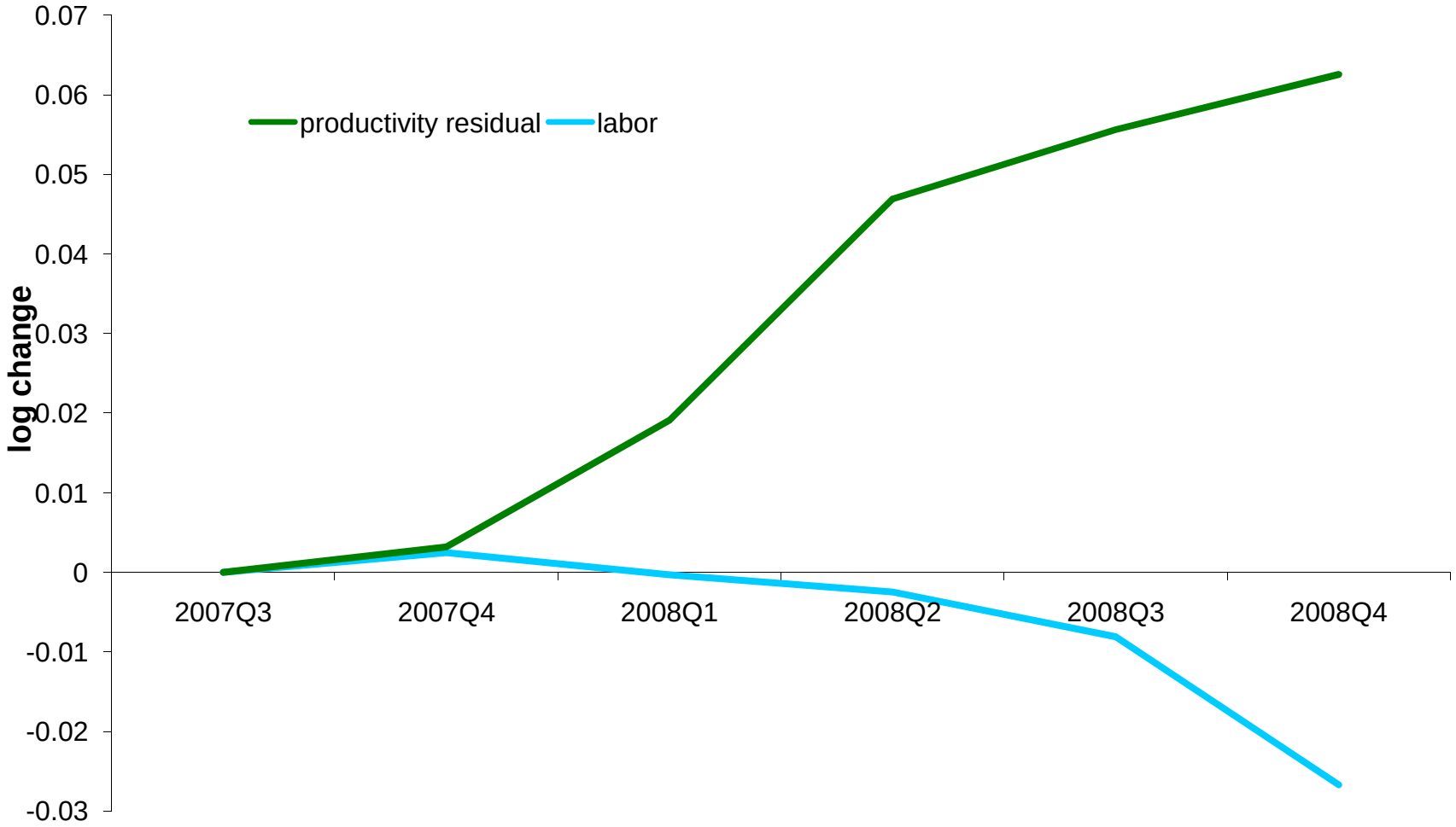


Fig 5. Productivity in 5 Recessions

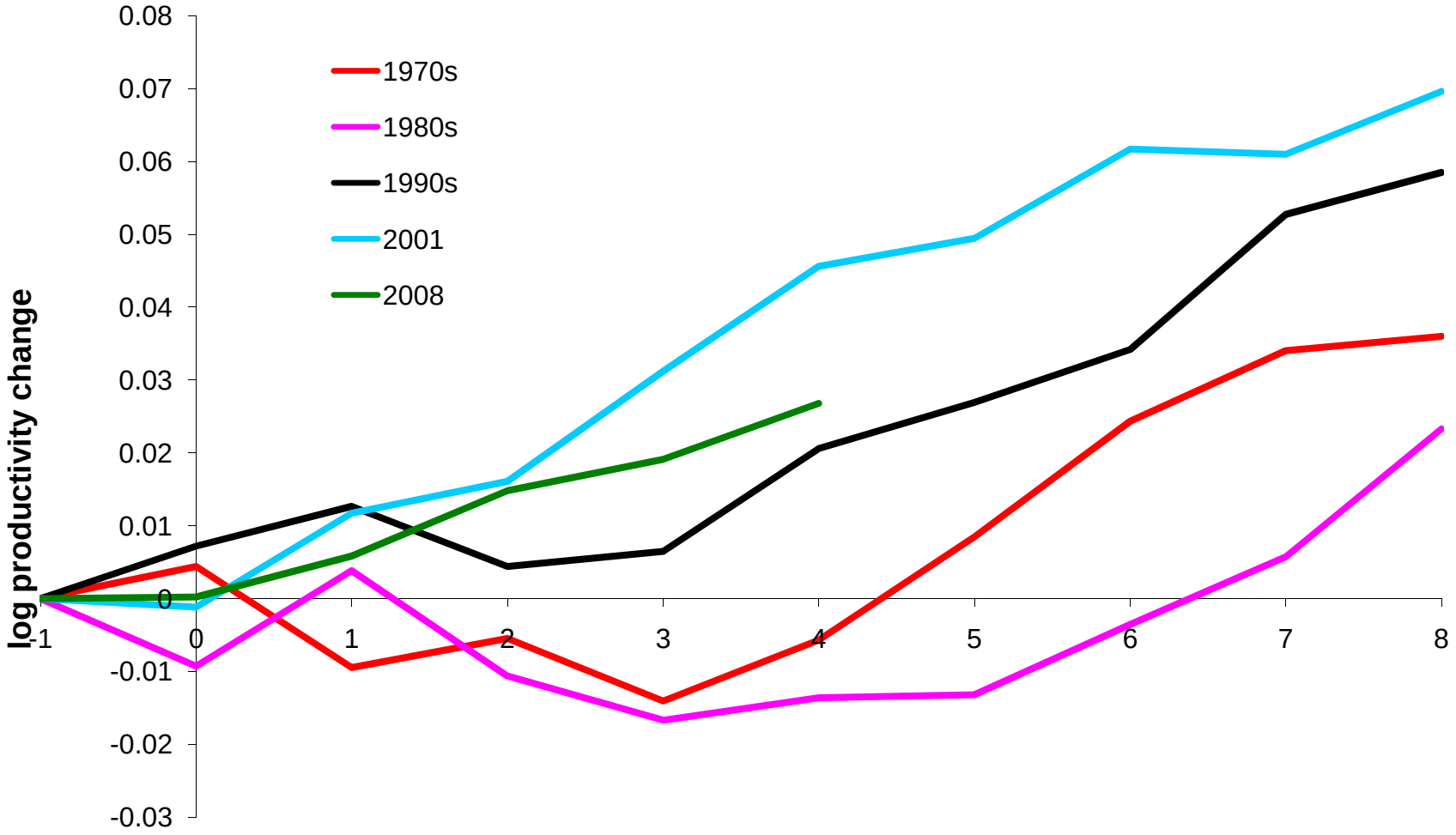


Fig 6. Productivity Residuals in 5 Recessions

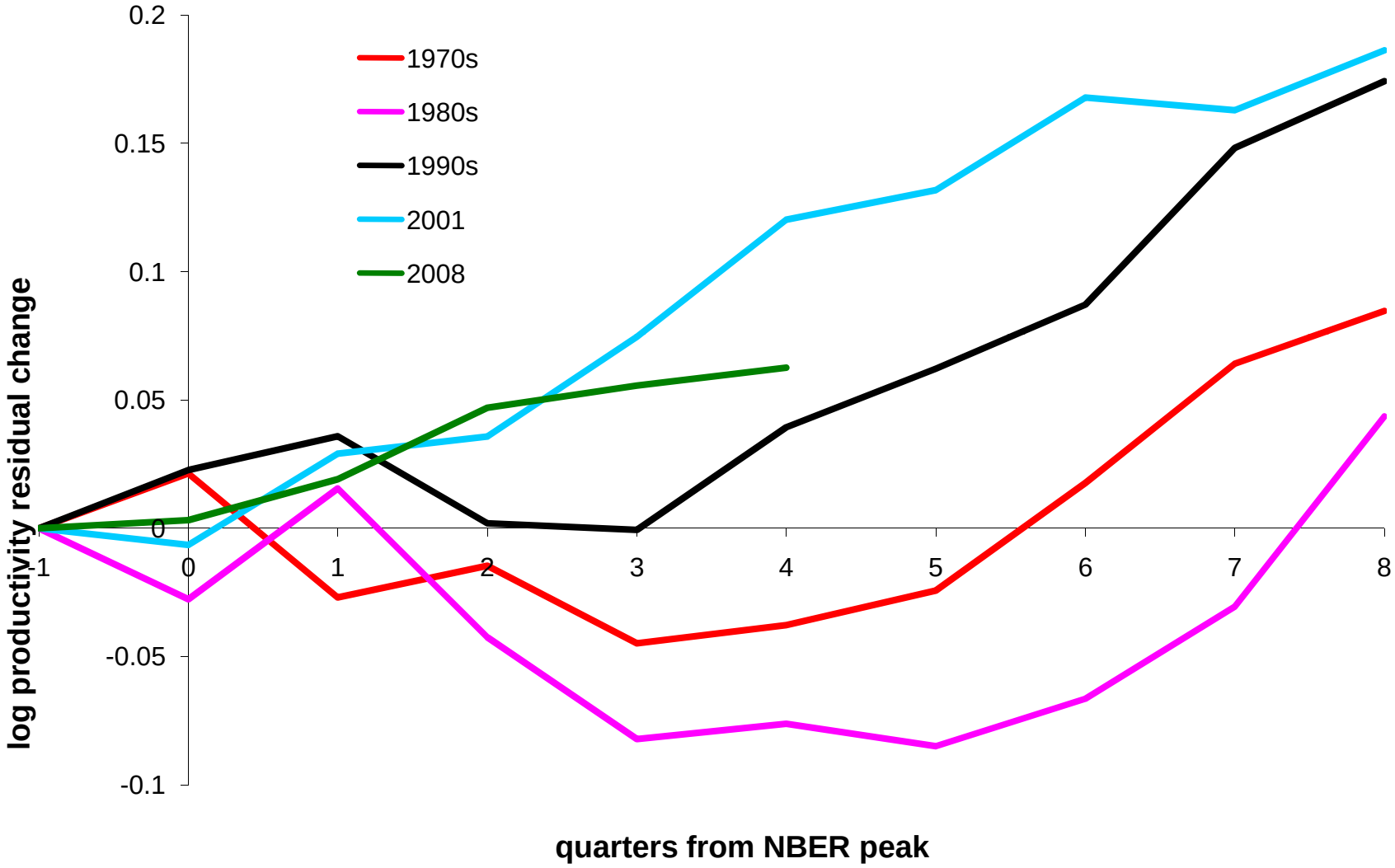


Fig 7. "Supply," "Demand," and Distortions during the 2008 Recession

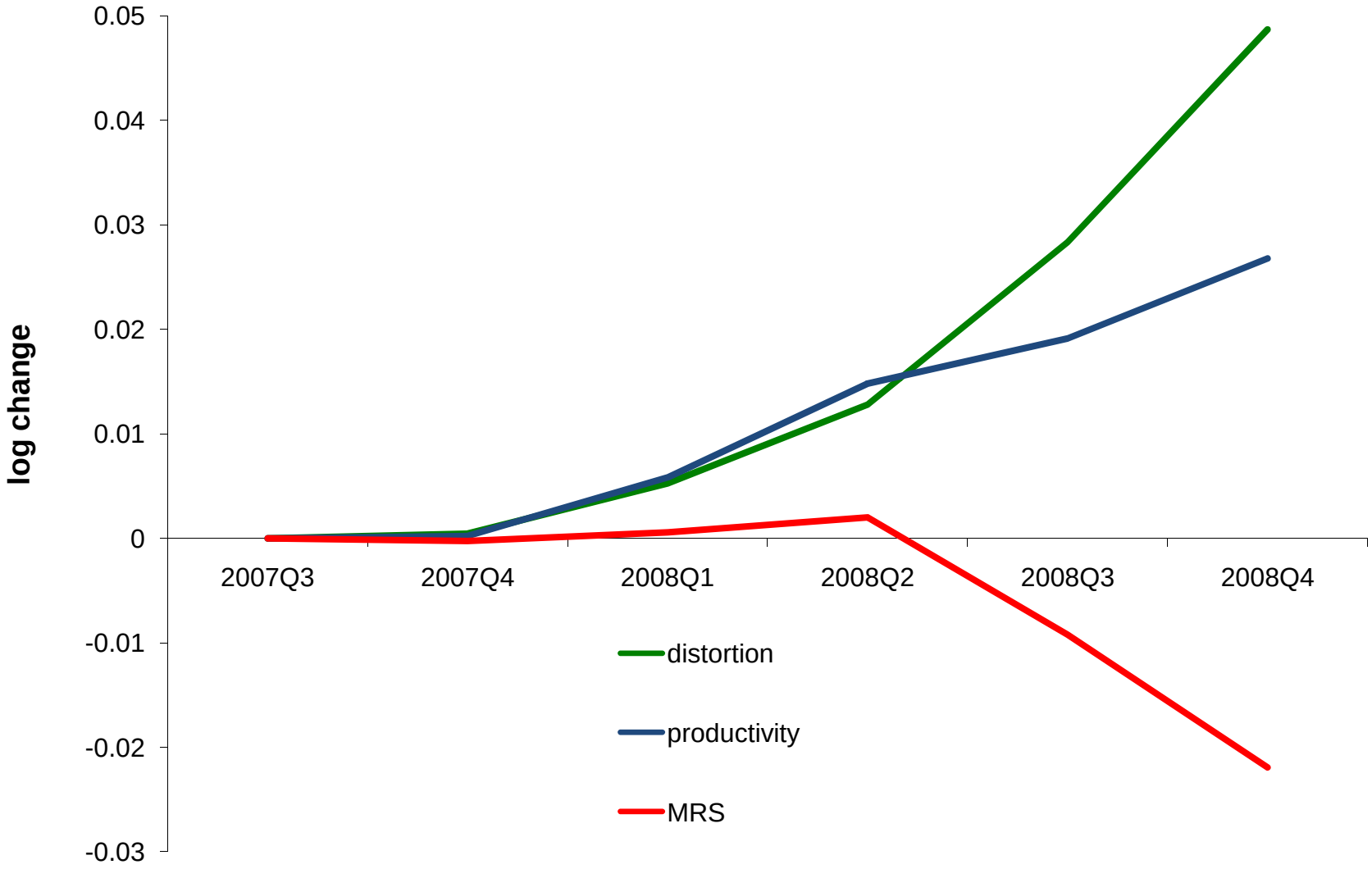


Fig 8. Quarterly Changes in the Consumption-Leisure Ratio in Five Recessions

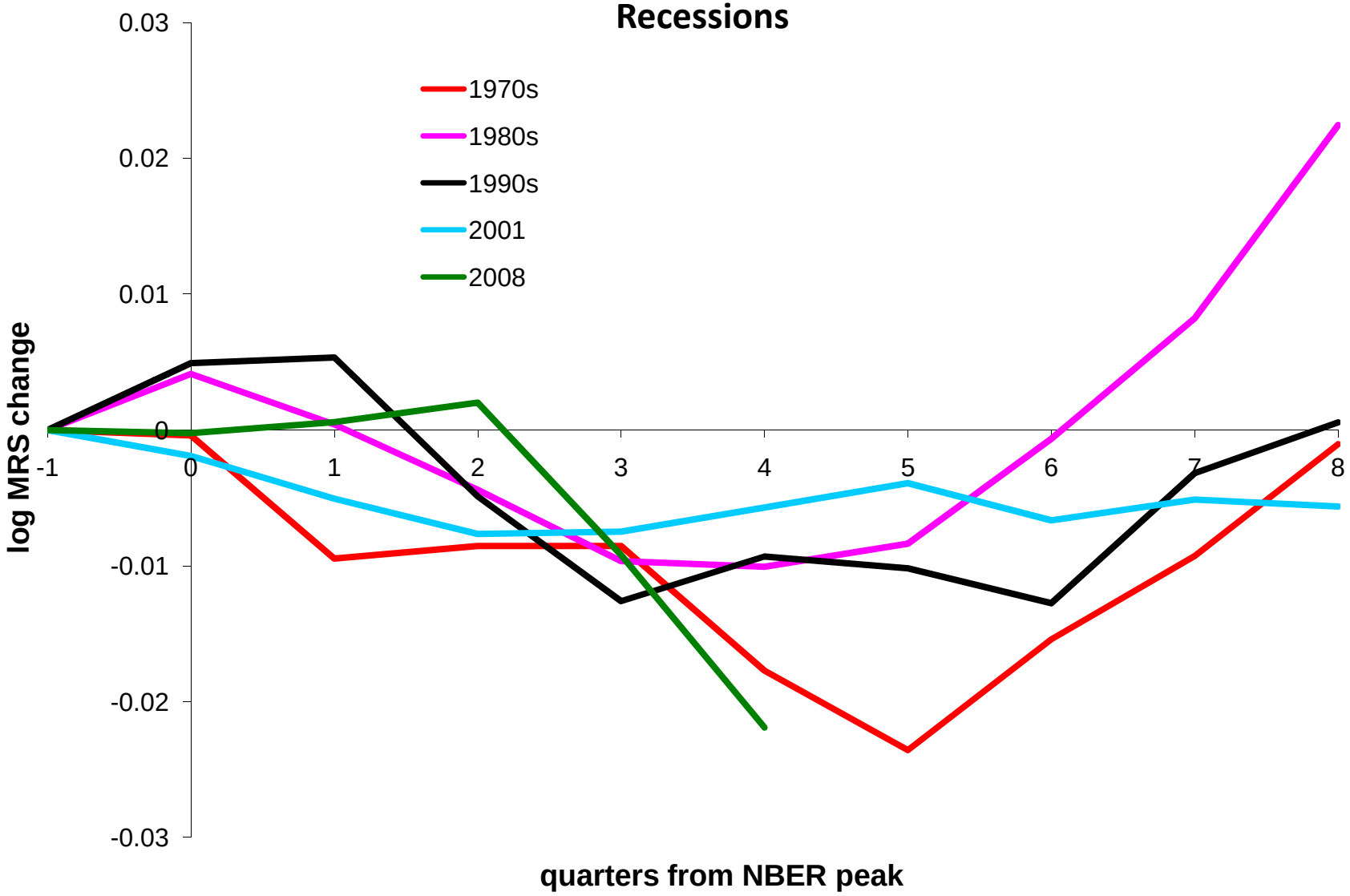
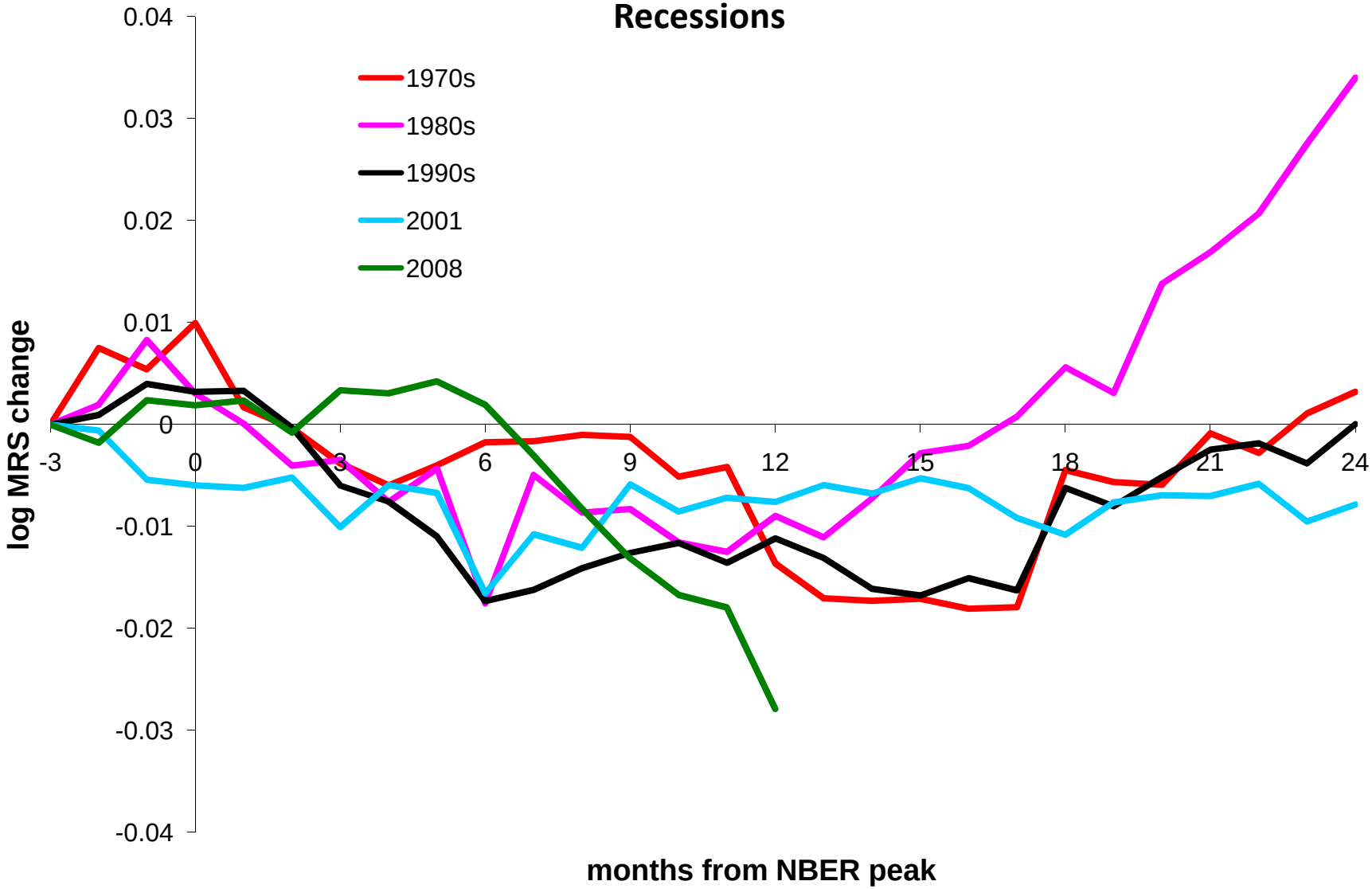


Fig 9. Monthly Changes in the Consumption-Leisure Ratio in Five Recessions



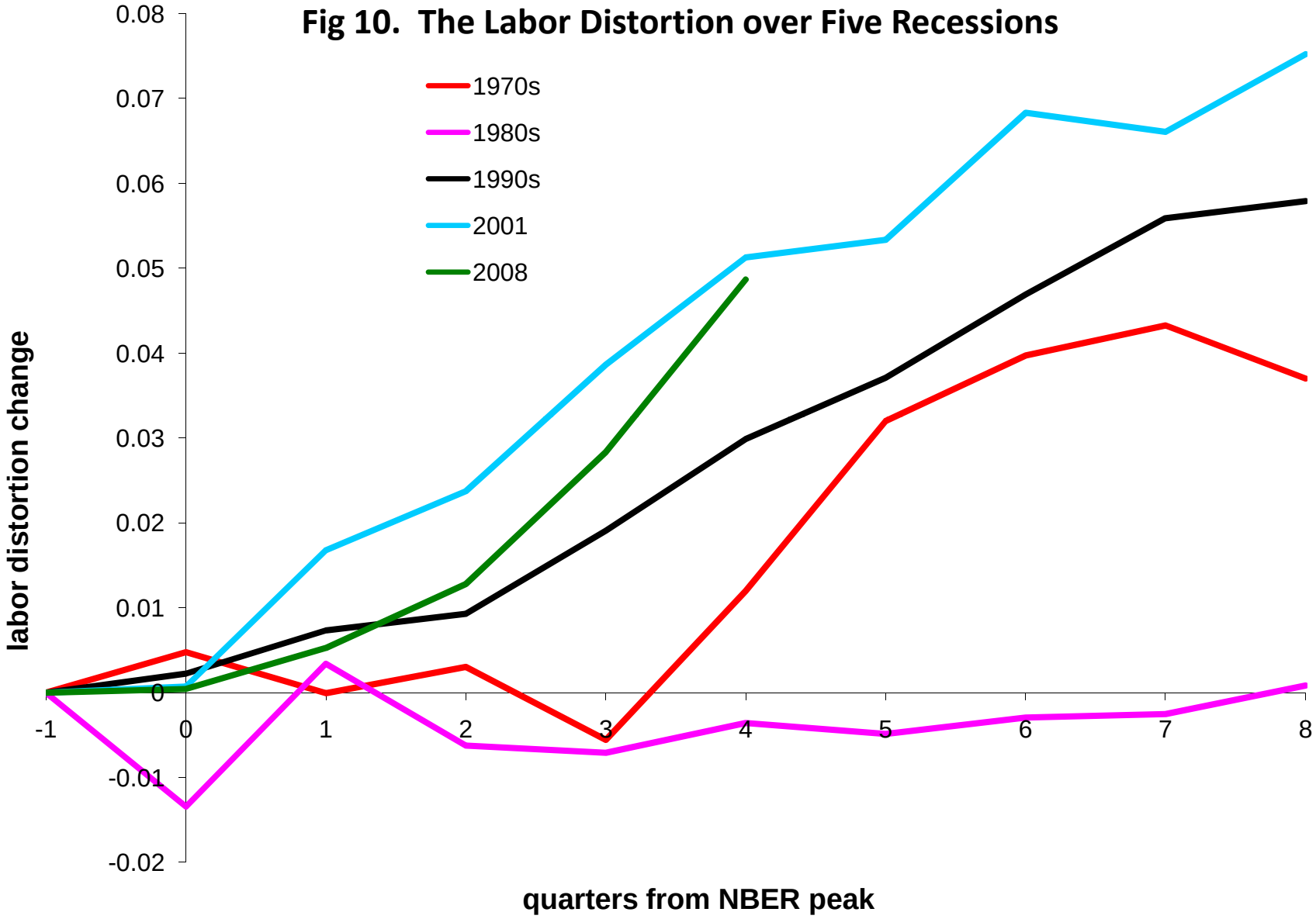


Fig 10. The Labor Distortion over Five Recessions
1970s
1980s
1990s
2001
2008
labor distortion change
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
-0.01
-0.02
-1
0
1
2
3
4
5
6
7
8
quarters from NBER peak

Fig 11. Mortgage Modification and the Budget Set (Slightly Under Water)

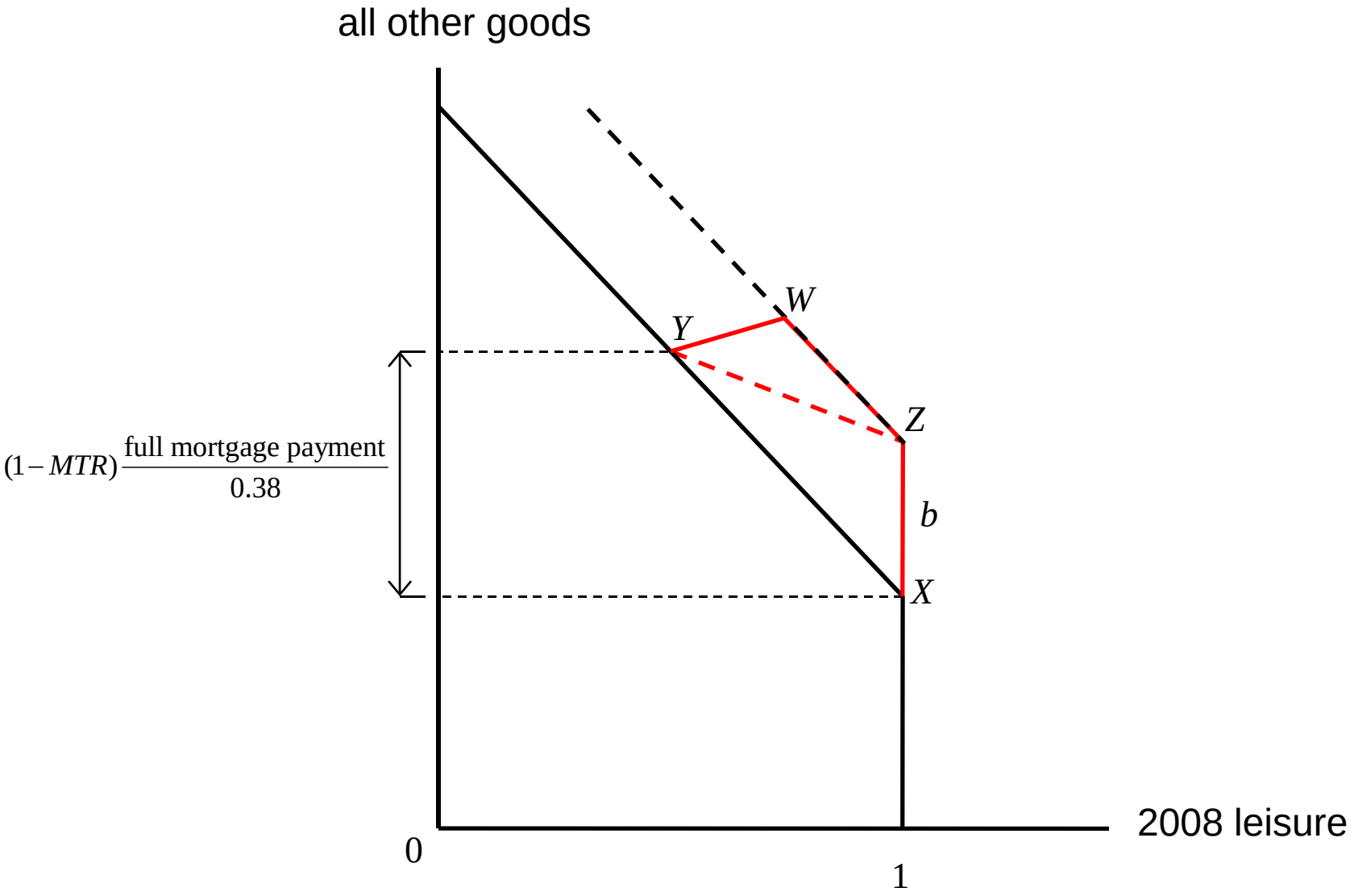


Fig 12. Mortgage Modification and the Budget Set (Deep Under Water)

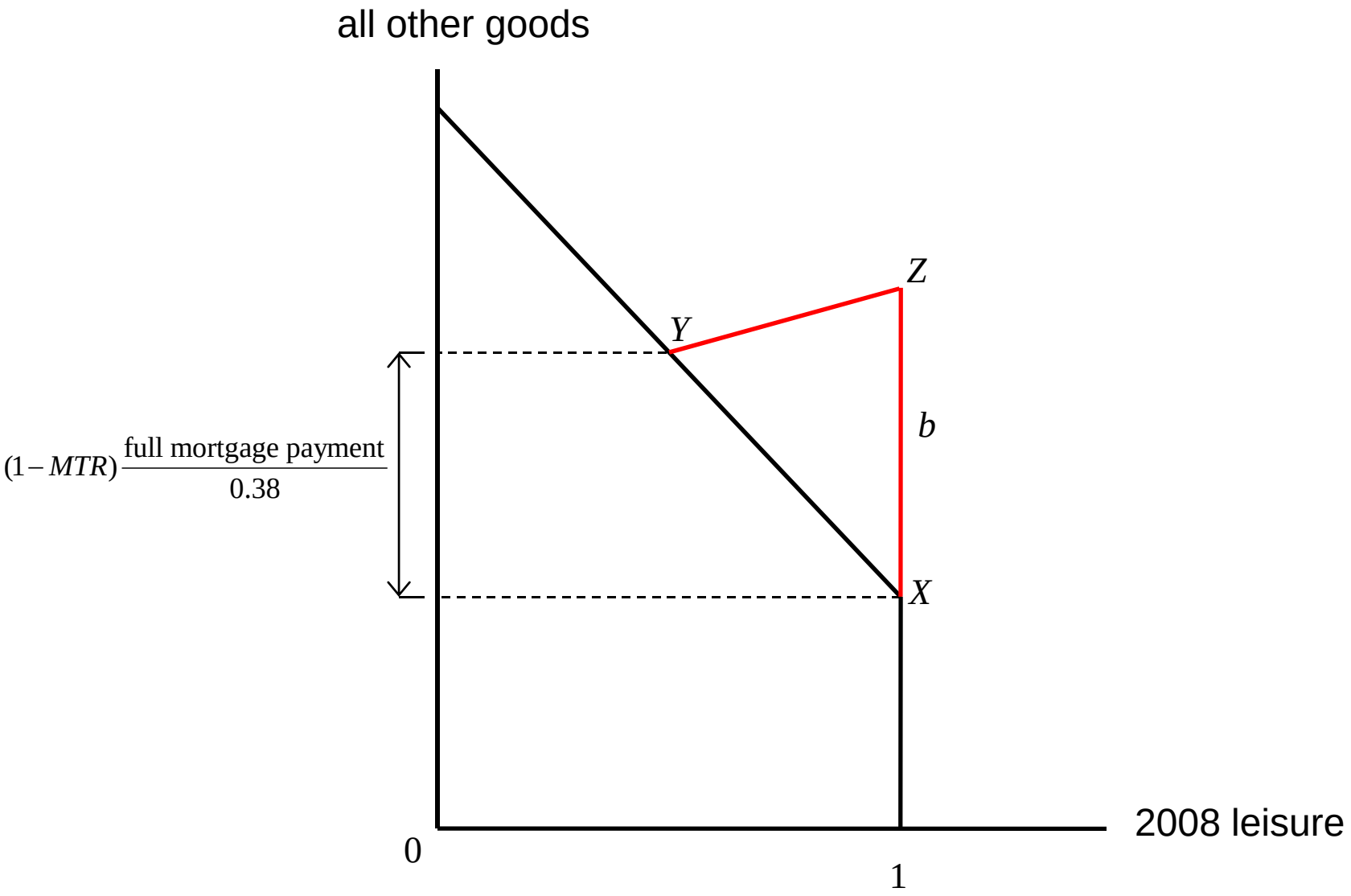


Fig 13. Labor Demand and Distortions, after 2 Quarters, in Five Recessions

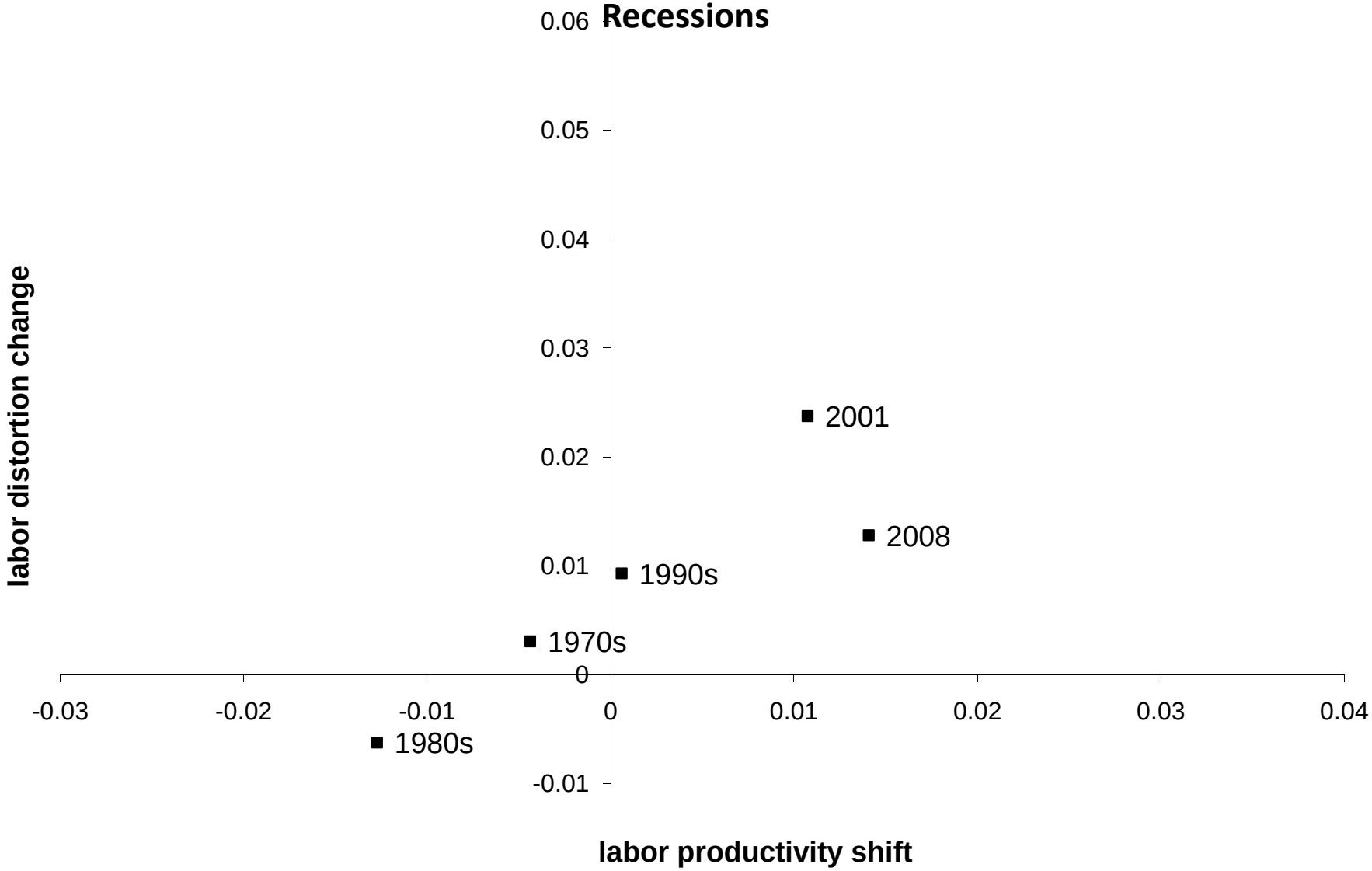


Fig 14. Labor Demand and Distortions, after 4 Quarters, in Five Recessions