

WORKING PAPER

2004

Department of Economics
Tufts University
Medford, MA 02155
(617) 627-3560
<http://ase.tufts.edu/econ>

ABSTRACT

Price Discrimination and the Long Boom

By Daniel J. Richards
Department of Economics*
Tufts University
Medford, MA 02155
e-mail: dan.richards@tufts.edu

This paper considers the possibility that an important role of computerization and information technology in strengthening the long boom of the 1990's may have been to lower price-cost margins principally by facilitating price discrimination and "versioning, or that this may be a convenient way to model this contribution. Such practices intensify price competition and force firms to exploit scale economies more fully. Simulations of a simple model suggest that these effects account for two percentage points of extra gdp or between one third and nearly all of conventional estimates of the extra production by the end of the 1990's.

Keywords: product differentiation, price discrimination, economic growth

JEL Classification Codes: L11, G16

*Preliminary Draft. Comments are welcome but please do not cite without prior permission of the author. I thank Dan Bernhardt, Erik Brynjolfsson, Jeffrey Fuhrer, Robert Lawrence, Gib Metcalf, Catherine Morrison Paul, George Norman, and Lynne Pepall for helpful comments.

Price Discrimination and the Long Boom

By Dan Richards

1. Introduction

The dominant economic story from 1992 through 2000 was the unprecedented economic expansion of those years—the longest in American history. In this interval, real gdp grew at an annual rate of 3.71 percent or nearly 34 percent on a cumulative basis. Similarly, nonfarm payroll grew by over 18 million as the unemployment rate fell from 7.5 percent to a low of 3.9 percent in May of 2000. Productivity growth also increased. Whereas output per person hour had averaged 1.4 percent growth from 1975 to 1995, it averaged over 2.6 percent growth over the last four years of the boom. A smaller but similar rise of 1.0 to 1.16 percent is observed in total factor productivity (TFP) [see Oliner and Sichel (2000) and Jorgenson and Stiroh (2000)].

Without doubt, the growth in output, employment, and productivity were unusually high. Post-sample predictions based on a simple time trend estimated through 1995, show output nearly two percent above trend by 1999. Likewise, the studies by Oliner and Sichel (2000) and Jorgenson and Stiroh (2000) suggest that the acceleration in growth raised real gdp by perhaps as much as six or percent above its projected level by the end of the decade. By any measure, employment was at least one percent above trend. In addition, the good news on output and employment was accompanied by equally surprising and favorable outcomes with respect to inflation. The inflation rate measured by the gdp deflator averaged just 1.84 percent even as unemployment dipped well below then current estimates (five percent or so) of the natural rate of unemployment.

Yet while there is little doubt about the key features of the long boom, there remains debate about its cause and, in particular, the role of information technology. To be sure, the fact that business investment in such technology tripled over the decade strongly suggests that rapid spread of computers and related equipment must somehow be part of any explanation of the fortunate economic outcomes. Precise identification of that contribution is, however, difficult. For this purpose, scholars such as Oliner and Sichel (2000), Jorgenson and Stiroh (2000), and Bosworth and Triplett (2000) use a production function approach in which the accumulation of information technology may affect economic growth through traditional capital deepening or by shifting the production technology and raising total factor productivity (TFP). Similarly, Brynjolfsson and Hitt (2003) use firm level data over eight years from the late 1980's to the early 1990's that

suggest that computerization may have led contributed anywhere from one to five percentage points of extra growth in the later part of the 1990's with the size of the estimate growing as more time is permitted for the computerization to have its effect. In these studies, however, the precise means by which computerization raises TFP is not easy to pin down.

However, besides the long boom, there was also another important economic story that played prominently in the 1990's. This is a story of mega-mergers and corporate downsizing. From 1992 on, each year saw a significant increase in the value of corporate mergers as a wave of mergers unfolded that in scope and scale was just as unprecedented as the economic growth. The numbers are staggering. The number of mergers grew by leaps and bounds, sometimes by over 20 percent in a year, and reached a record of well over 9,000 by the end of the decade. The dollar volume of US mergers grew just as dramatically from just about \$150 billion in 1992 to over \$1.5 trillion in 2000.¹ The list of merging firms extends from the very smallest to many of America's largest companies. Turner Communications became part of TimeWarner, which was then combined with AOL. Chemical Bank swallowed Chase (although it chose Chase as the name of the surviving entity). MCI was acquired by WorldCom.

Accompanying these mergers was a wave of corporate downsizing as the merging firms rationalized their production. This downsizing was significant. For instance, when AOL acquired Netscape, over 10 percent of Netscape workers were laid off. The Chemical Bank and Chase Manhattan merger was accompanied by a loss of 16 percent of the two firms' combined workforce and a closing of 21 percent of their 480 branch offices. Indeed, as the decade progressed, the popular press witnessed more and more articles about downsizing and job insecurity.²

This paper explores the possibility that the two economic stories just described may be related. As a result, it considers an alternative view regarding the mechanism by which computerization and information technology may have fostered the economic boom. The possibility explored here stems from the fact that such technology intensifies price competition and thereby forces firms to exploit scale economies more intensively. The

¹ See *MergerStat Review*, 1993-2001.

² See, for example, N. R. Kleinfeld, "The Downsizing of America", *New York Times*, March 4, 1996, p. c1.

principal mechanism by which margins are reduced here is by means of price discrimination in product-differentiated industries. I focus on this mechanism for two reasons. First, while the Internet and other computer-related developments may make competition fiercer simply by facilitating comparison shopping it is difficult to quantify this effect theoretically. In contrast, the model that I employ permits a theoretical estimate of the price effect of permitting price discrimination that may then be used in a general equilibrium simulation. The second reason is that there is ample evidence that the price discrimination force is a real one.³ Computer-based flexible manufacturing techniques permits customization or, as Shapiro and Varian (1999) call it, versioning on a very wide-scale. Similarly, the growth of large-scale retailers such as Home Depot and Wal-Mart that buy in bulk and receive quantity discounts also reflects price discrimination at work. Moreover, many Internet-based services such as priceline.com and expedia.com are essentially just price discrimination services that allocate unused airline or hotel space to price-sensitive customers. Such examples are easily expanded.

As is well-known competition with discriminatory prices is more fierce, i.e., yields a smaller margin over cost.⁴ Even if this happens in only a few sectors, its impact can still be large because it will spill over into lower prices and more output in other sectors as well as increases in real wages and employment. With this in mind, the paper explores the likely price reducing and output expanding effects of such an outbreak of price competition via discriminatory pricing when plausible parameters from the real world are used to simulate a simple two-sector model. To put it slightly differently, the paper is a rather extensive back-of-the-envelope exercise intended to examine the conditions under which an important contribution of the new information technology to the long boom of the 1990's may come from the enhanced competition such technology facilitates. To preview the results, the model suggests that about two of the two to six extra percentage points of cumulative growth from 1996 to 2000, may be due to intensified price competition. A further attractive aspect of the model is that it also predicts that such competition will be associated with a merger wave and downsizing.

2. The Model

I consider an economy comprised of two sectors. Each sector uses only labor as an input. Sector 1 is

³ See for example, N. Templin, "Hotels Adopt System Used by Airlines That Help to Maximize Room Rates." *Wall Street Journal*, 5 May, 1999, p A1.

⁴ See, for example, Norman and Thisse (1996).

modeled as one of monopolistic competition along the lines suggested by Salop's (1979) circle model, which implies increasing returns to scale. Sector 2 is modeled as a perfectly competitive sector with (slight) scale diseconomies. The model is closed by application of aggregate or macroeconomic relations describing the behavior of nominal income, the aggregate price index, and the aggregate labor supply. Each of these is discussed in turn.

However, before discussing the specifics of each of the model's main components, let me just point out that the two-construction is a simplification of the process I have in mind. Most firms are multiproduct organizations that participate in a number of markets. Banks compete both for deposits and for loan customers. Financial institutions more broadly may participate in credit extension and in underwriting, among other activities. Oil companies explore and produce natural gas and petroleum, and also refine and market petroleum products. Hotels provide lodging and meals. Often, they are also part of an organization that provides entertainment such as those run by theme parks, or ski lodges, and casinos. As described below, if price competition becomes more intense in one of the firm's activities, it may merge with a former rival and rationalize—downsize—the volume of inputs in that activity. Those inputs will then seek alternative employment, which they may find in the other activities in which the firm engages. When this happens then, using standard industry data, the released resources will not actually move to a separate sector but remain in the same general industry. The two sector model employed is then just a convenient device to capture the impact of intensified price competition in some parts of the economy and the transfer of resources from those sectors to other areas. It is not a literal description of reality.

2a. Sector 1: Monopolistic Competition with Scale Economies

Production in sector 1 requires a fixed cost F and incurs constant marginal cost. The fixed cost reflects an amount of labor necessary for any production level. Without loss of generality, units are chosen so that the marginal cost is equal to the nominal wage W . These cost assumptions imply that sector 1 enjoys economies of scale. Initially, there is no price discrimination in this sector. I also make the conventional assumption that the market is “covered” in that all N potential consumers of this sector's output are actual consumers with each consuming one and only one unit of output. If t is the consumer disutility per “distance”

from one's most preferred version, the equilibrium price in this sector without price discrimination is:

$$p_1 = W + t/M \quad (1)$$

where M is the number of firms. With M chosen so that each firm makes zero profit, its equilibrium value is:

$$M = \sqrt{\frac{tN}{F}} \quad (2)$$

In turn, this means that the equilibrium price is

$$p_1 = W + \sqrt{\frac{tF}{N}} \quad (3)$$

This price level is not that critical to the analysis. What is crucial is how this price changes when one suddenly permits first-degree price discrimination. In that setting, for any consumer located midway between two firms, the two goods are perfect substitutes. Accordingly, Bertrand competition makes the store price to that consumer fall to marginal cost or W . Similarly, for consumers located somewhat closer to a particular firm, the ability of the next closest firm to sell to those customers at a shop price of W puts a limit on the maximum price charged by the closest firm—a limit that rises linearly as one considers consumers living progressively closer to a particular firm. If the circle is normalized to be of unit circumference so that the distance between firms is $1/M$, the highest price that a firm can charge is $W + t/M$. This is the price that may be charged to the consumer who lives at exactly at the location of a particular shop. To buy from the next closest shop would incur a travel cost of t/M , so that any price above $W + t/M$ would permit the next nearest rival to steal the consumer and still make a profit.

Note that the highest price, $W + t/M$, charged to any consumer when there is price discrimination is the average price without price discrimination. The lowest price with discrimination is W . That is, the average sector 1 price falls with the onset of price discrimination. How far it falls is easily calculated. Because price rises linearly from W to $W + t/M$, the average price under discriminatory pricing is $W + t/2M$. Thus, the average price falls with the onset of discrimination. In turn, this reduces the equilibrium number of firms. It is easy to show that the zero-profit constraint now implies that the number of firms is:

$$M = \sqrt{\frac{tN}{2F}} \quad (4)$$

In turn, this implies a new equilibrium price of:

$$p_1 = W + \sqrt{\frac{tF}{2N}} \quad (5)$$

A comparison of equations (2) and (4) makes clear that for *any* value of t , N , and F , the equilibrium number of firms shrinks by a factor of $1/\sqrt{2}$ or by 29.3 percent.⁵ This is also the percentage decline in the absolute amount by which the pre-discrimination price exceeded marginal cost W . If that markup is expressed as a percentage of the initial price, i.e., if the pre-discrimination price can be expressed as $p_1 = W(1+X_0)$ then the proportional change in sector 1's price after the introduction of discriminatory pricing is:

$$\frac{dp_1}{p_1} = \frac{dW}{p_1} - 0.293 \frac{X_0 W}{p_1} = \frac{dW}{(1+X_0)W} - 0.293 \frac{X_0}{(1+X_0)} \quad (6)$$

For example, with an initial markup of $x = 50$ percent, the sector 1 price would fall by nearly 10 percent with the advent of price discrimination and abstracting from any movement in wages.

As noted, the assumption that the market was initially discriminatory pricing would also reduce the number of firms in sector 1 by about 29 percent. By virtue of the assumption that the market was covered this would not lead to any fall in output. It would simply force firms to operate more efficiently and to exploit more fully the scale economies inherent in their cost structure. However, this decline in the number of firms *would* release overhead labor and capital from this sector. For convenience, I work with a single-factor model and call that single input, labor. Assume that in the initial, pre-discrimination state, a fraction ϕ of the total labor supply L^0 was employed in sector 1, so that $(1-\phi)L^0$ was employed in sector 2. Assume as well that, initially, each firm in sector 1 employs the fraction μ of its labor as overhead. This fraction can be lowered if firms operate on a larger scale. Initially, the total labor L_1 in sector 1 may be expressed as $\phi/(1-\phi)$ times the labor L_2 in sector 2. Of this initial L_1 labor, the fraction μ is overhead. By permitting a more complete exploitation of scale economies, the advent of price discrimination will therefore releases an amount of labor from sector 1, S_{12} , and available to sector 2 without any change in wages equal to:

$$S_{12} = 0.293 \mu \left(\frac{\mathbf{f}}{1-\mathbf{f}} \right) L_2 \quad (7)$$

Thus, if μ is 0.2 and the two sectors initially have equal amounts of labor ($\phi = 0.5$), then the onset of price discrimination in sector 1 will release labor equal to about six percent of sector 2's initial employment.

⁵ As noted previously, these values may reflect the percentage shrinkage in divisions and not necessarily in firms.

2b. Sector 2: Perfect Competition and Diseconomies of Scale

I now consider sector 2. Here, I assume perfectly competitive firms whose production is given by:

$$q_2 = L_2^\alpha; \text{ where } 0 < \alpha < 1 \quad (8)$$

With a wage of W , the firm's in this sector face a total cost of $C = Wq_2^{1/\alpha}$. Competitive pricing then implies

$$\frac{dp_2}{p_2} = (1-\alpha)\frac{dL_2}{L_2} + \frac{dW}{W} \quad (9)$$

Alternatively, demand for labor in this sector changes according to the equation

$$\frac{dL_2}{L_2} = \frac{1}{1-\alpha} \left(\frac{dp_2}{p_2} - \frac{dW}{W} \right) \quad (10)$$

2c. Macro Relationships

Let me now turn to the macro side of the model. Since the goal is to isolate the contribution of price discrimination, I wish to eliminate any role for monetary and fiscal policies. I do this by assuming both a constant money supply and constant velocity of money. In turn, this implies that total dollar spending, nominal gdp, remains constant through the exercise. That is, $p_1q_1 + p_2q_2$ does not change. Further, and as noted above, the real output of sector 1 is also unchanged by virtue of the assumption that that market is initially covered. Hence,

$$0 = q_1dp_1 + p_1dq_1 + q_2dp_2 + p_2dq_2 = q_1dp_1 + q_2dp_2 + p_2dq_2 \quad (11)$$

Equation (11) may also be expressed in proportional terms

$$\frac{p_1q_1 \left(\frac{dp_1}{p_1} \right)}{p_1q_1 + p_2q_2} + \frac{p_2q_2 \left(\frac{dp_2}{p_2} \right)}{p_1q_1 + p_2q_2} + \frac{p_2q_2 \left(\frac{dq_2}{q_2} \right)}{p_1q_1 + p_2q_2} = 0 \quad (12)$$

Let the initial fraction of nominal gdp accounted for by sector 1 be λ , so that $1 - \lambda$ is the fraction accounted for by sector 2. Then, equation (12) may be rewritten as:

$$\lambda \frac{dp_1}{p_1} + (1-\lambda) \frac{dp_2}{p_2} + (1-\lambda) \frac{dq_2}{q_2} = 0 \quad (13)$$

Alternatively, nominal gdp may be thought of as the product of an aggregate price level P and aggregate real gdp Q where the latter is defined as nominal income deflated by the aggregate price index, i.e., $Q = (p_1q_1 + p_2q_2)/P$. I assume that the aggregate price index is given by:

$$P = p_1^\theta p_2^{1-\theta}; \text{ where } 0 < \theta < 1 \quad (14)$$

In principle, the parameter θ reflects the weights of each sector's output in household utility

functions and should be close to the income shares of each good, λ . In the analysis below, however, I do not impose this constraint and simply permit θ and λ to take on different values.

Finally, the aggregate labor supply L is given by:

$$L = Z \left(\frac{W}{P} \right)^\epsilon \quad (15)$$

where Z is an arbitrary constant, W/P is the aggregate real wage, and ϵ is the elasticity of labor supply. It follows that

$$\frac{dL}{L} = \epsilon \left[\frac{dW}{W} - \mathbf{q} \frac{dp_1}{p_1} - (1-\mathbf{q}) \frac{dp_2}{p_2} \right] \quad (16)$$

3. Simulated Effects of the Emergence of Price Discrimination in Sector 1

Establishing a new equilibrium following the emergence of price discrimination in sector 1 requires, *inter alia*, that the changes in factor (labor) supply equal the changes in factor (labor) demand. The supply response reflects two forces. First, there is the amount S_{12} of overhead labor released by sector 1 and available for employment in sector 2 as given by equation (7). Second, there is the change in aggregate labor supply that comes about as the result of any induced movement in the real wage as given by equation (16). Together, these two supply forces must equal any change in labor demand coming from sector 2 as described by equation (10). Recalling that the employment in sector 2 was initially the fraction $(1-\phi)$ of the total labor supply L^0 so that we may write $L^0 = L_2 / ((1-\phi))$, we then have

$$0.293 \mathbf{m} \left(\frac{\mathbf{f}}{1-\mathbf{f}} \right) L_2 + \epsilon \left[\frac{dW}{W} - \mathbf{q} \frac{dp_1}{p_1} - (1-\mathbf{q}) \frac{dp_2}{p_2} \right] \left(\frac{L_2}{1-\mathbf{f}} \right) = \frac{1}{1-\mathbf{a}} \left(\frac{dp_2}{p_2} - \frac{dW}{W} \right) L_2 \quad (17)$$

There are three endogenous variables: dp_1 , dp_2 , and dW . To solve for these we need two additional equations. Marginal cost pricing in sector 2 implies:

$$\frac{dq_2}{q_2} = \frac{\mathbf{a}}{(1-\mathbf{a})} \left[\frac{dp_2}{p_2} - \frac{dW}{W} \right] \quad (18)$$

Together with the macroeconomic constraint on the change in nominal income [equation (13)] this implies:

$$\lambda \frac{dp_1}{p_1} + (1-\lambda) \frac{dp_2}{p_2} + \frac{(1-\lambda)\alpha}{(1-\alpha)} \left[\frac{dW}{W} - \frac{dp_2}{p_2} \right] = 0 \quad (19)$$

Now, add equation (6) describing the change in sector 1 prices as a function of the change in wages and the

initial markup. Then, repeated substitution into the labor market clearing condition, equation (17) yields:

$$\frac{\left[\frac{k_1(1-\phi)}{(1-\alpha)} + k_1\varepsilon(1-\theta) + k_2(1-\lambda) \left(\frac{\alpha}{(1-\alpha)} + 1 \right) \right] \frac{dp_2}{p_2}}{k_1k_2} = \frac{\left[k_2 \left(\frac{0.293\lambda X}{1+X} \right) + 0.293k_1 \left(\mu\phi + \frac{\varepsilon\theta X}{(1+X)} \right) \right]}{k_1k_2} \quad (20)$$

where: where: $k_1 = \left[\frac{\lambda}{(1+X)} + \frac{(1-\lambda)\alpha}{(1-\alpha)} \right]$ and $k_2 = \left[\varepsilon - \frac{\varepsilon\theta}{(1+X)} + \frac{(1-\phi)}{(1-\alpha)} \right]$ (22)

Solving for the change in sector 2's price, one then obtains:

$$\frac{dp_2}{p_2} = \frac{0.293 \left[k_2 \frac{\lambda X}{(1+X)} + k_1 \left(\mu\phi + \frac{\varepsilon\theta X}{(1+X)} \right) \right]}{k_1 \left[\frac{(1-\phi)}{(1-\alpha)} + \varepsilon(1-\theta) \right] + k_2(1-\lambda) \left[\frac{\alpha}{(1-\alpha)} + 1 \right]} \quad (23)$$

One may then work recursively to solve for the other two endogenous variables, dp_1/p_1 and dW/W , as well as the change in sector outputs, employment, and aggregate price level that these imply.

3a. A Baseline Case

I first report a baseline calculation. For this purpose, I need to assume values for the exogenous parameters. For the initial markup in sector 1, I set $X_0 = 0.40$. Treating W as marginal cost, the estimates by Hall (1988) suggest that X_0 might range between 0.26 and 0.54. Domowitz, Hubbard, and Petersen (1988) suggest an average Lerner Index in manufacturing of 0.37, implying that $X_0 \approx 0.59$. More recently, data compiled by Rangan and Lawrence (1999) imply that $X_0 = 0.282$ in manufacturing. However, this smaller margin in the 1990's may reflect precisely the intensifying of competition via price discrimination hypothesized in this paper. In light of all the estimates, an initial setting of $X_0 = 0.43$, the midpoint of the estimated upper and lower bounds, seems reasonable.

The price discrimination assumed by the model is of the first degree variety. In reality, while there is little doubt that price discrimination techniques have spread to a large segment of the economy the likelihood that it is first degree seems strong. Therefore, I attempt to correct for this by limiting the relative size of sector 1 in which price discrimination is assumed to be implemented. The sectors in which such pricing is most probable are retail trade, services, and the financial and insurance services industries. These each accounted for roughly 11, 19, and 18 percent of real gdp, respectively, during the last half of the 1990's. In turn, this would

suggest that significant price discrimination was being practiced in sectors accounting for somewhere between 11 and 48 percent of total output. In the baseline estimate, I use just below the midpoint (29 percent) of this range as the value of λ_0 , as the initial share of nominal income initially accounted for by sector 1. For analytical simplicity, the baseline case also assumes that 0.29 is the weight given to sector 1 prices in the aggregate price index as well as the fraction of the total labor supply initially employed in that sector. That is, I set $\phi_0 = \theta_0 = \lambda_0 = 0.29$.

I next consider the fraction μ_0 of the inputs in Sector 1 that are overhead. Basu (1995) suggests that the share of overhead labor and capital combined in total costs is about 0.5. If one considers only the overhead labor that this implies then, assuming two-thirds of this cost is overhead labor, it would imply that $\mu_0 = 0.33$. This seems rather large but, as labor is the only input in this model, it really is a proxy for all inputs including capital. In this connection, assuming that one-third of the inputs are fixed as implied by $\mu_0 = 0.33$, may not be a bad assumption. Indeed, in an insightful article modeling the incentives facing defense contractors, Rogerson (1992) provides data that overhead labor alone accounts for somewhere between 20 to 28 percent of total cost, which is not that much below $\mu_0 = 0.33$. In an effort to be prudent, I start with a setting of $\mu_0 = 0.20$, i.e., I assume that 20 percent of the costs a typical firm incurs in Sector 1 are overhead or fixed costs.⁶

The critical parameter to be set for sector 2 is that sector's degree of scale economies or diseconomies, α . Of course, the larger this is, the larger the output growth that will occur when resources released by sector 1 flow into sector 2. In this regard, it is noteworthy that many authors, e.g., Hall (1990) and Basu and Fernald (1997), find significant scale economies at the level of aggregation used here. However, using disaggregated plant-level data, Bailey, Hulten, and Campbell (1992) find only constant returns to scale, while Burnside, Eichenbaum, and Rebelo (1995) find that at the three-digit level, individual manufacturing industries exhibit decreasing returns to scale with α typically between 0.8 and 0.9. As Basu and Fernald (1997) point out, significant decreasing returns would imply greater profitability than is typically observed. When they correct

⁶ This seems roughly consistent with anecdotal data, e.g., the Chemical and Chase bank merger which, as noted above, led to a layoff of 16 percent of the combined workforce and a closing of 21 percent of the branch offices. Here again, it is important to recall that the non-discriminatory sector may involve other divisions of the merging firms so that the announced layoffs are less than the actual downsizing of the affected areas.

the aggregate data for the problems arising from underlying heterogeneity, they find essentially constant returns to scale. Again, the greater are the returns to scale in sector 2, the more the restructuring of sector 1 will lead to aggregate output growth. In an attempt to be both cautious and realistic, I choose an initial value of $\alpha = 0.9$

The last parameter to be set is the aggregate factor (labor) supply elasticity, ϵ . Most work, e.g., Heckman and MaCurdy (1980), Altonji (1986), and Blundell and MaCurdy (1999) finds an aggregate labor supply elasticity ranging from 0 to 0.5. I therefore set $\epsilon = 0.25$, the midpoint of this range, for the baseline case.

Table 1 shows the simulated changes for six key variables following the introduction of price discrimination in sector 1 and assuming the baseline values for the other key parameters. The results are qualitatively quite striking. As expected, the sector 1 price falls. This both releases resources to Sector 2 and, serves to raise the real wage thereby generating more labor supply and increasing the resources available to Sector 2 still further. Employing these additional inputs in sector 2 requires that prices in that sector still rise as a result of the increasing marginal cost. However, this price rise is fairly negligible with the result that real wages and therefore total employment still increase.

Table 1—Results of Baseline Simulation

Proportionate Change In Sector 2 Price	Proportionate Change In Nominal Wage	Proportionate Change In Sector 1 Price	Proportionate Change In Sector 2 Output	Proportionate Change In Real GDP	Proportionate Change In Total Employment
0.00615	0.00293	-0.08605	0.02898	0.02059	0.00588

Overall, real gdp increases by over 2 percent as a result of the advent of price discrimination in sector 1. This is equal to the lower bound estimate mentioned above and over one third of the upper bound increase estimated by Oliner and Sichel (200) and Jorgenson and Stiroh (2000). Note too that the increase in real gdp is accompanied by a quite plausible increase in aggregate productivity. With total employment only six tenths of a percentage point above its pre-discrimination level and gdp about 2 percent higher, productivity rises by about 1.4 percent. Again, labor is the only input in this model so this estimate is most accurately thought of as the increase in total factor productivity. Hence, the model's productivity implications are quite consistent with earlier econometric estimates on total factor productivity growth.

The higher productivity is not spread evenly among the sectors. Sector 1 experiences about a six percent productivity increase as a result of rationalization of its production. In contrast, sector 2 must absorb both the inputs released from sector 1 plus the net increase in total labor supply, which in total implies input growth of 2.2 percent. With diminishing returns, Sector 2 productivity must decline. However, this decline is small. Given that $\alpha = 0.9$, productivity in this sector declines by one-tenth of the input growth or by 0.22 percent. That is, employment in Sector 2 increases by 2.2 percent while output rises by only a slightly smaller 2 percent.

A further feature of the baseline simulation is that both real wages and profits rise. Because I assume nominal income is held constant, the rise in real gdp is mirrored by a fall in the aggregate price level of an equal amount. When added to the small growth in nominal wages, real wages rise by 2.2 percent.

The movement in profits is more complicated. In Sector 2 profits are clearly higher. Total revenue increases by 2.6 percent, while the nominal wage bill rises by 2.4 percent. Thus, profits increase by 0.2 percent nominally in Sector 2 or by over two percent in real terms. A similar calculation for Sector 1 yields an 8.6 percent decline in revenue coupled with a six percent decline in labor costs so that here nominal profit declines by 2.6 percent or by 4.6 percent in real terms. Given that Sector 1 accounts for only 22 percent of total output, the weighted change in real corporate profits is a positive 0.7 percent.⁷

In sum, the baseline simulation suggests that it may well be the case that information technology played a significant role in the long boom of the 1990's by helping to facilitate price competition via discrimination in differentiated product industries. Even without any change in the production function, such increased discrimination would have yielded noticeably higher levels of real gdp and employment, and increased factor productivity, all while exerting a moderating influence on the price level. Again, this effect comes about because price discrimination intensifies price competition. When firms can change the price to any one consumer without changing it to others, the disincentive of lowering the price to any consumer is diminished. In this setting, each consumer becomes a battleground in which price competition is relatively fierce.

Before turning to a consideration of the robustness of these results, let me emphasize a second point noted

⁷ Note that while profits fall in Sector 1 so does the number of firms and, in fact, profit per firm actually rises. Sector 2's profit increase reflects the fact that it has an upward-sloping supply curve so that expansion raises infra-marginal profits.

earlier. This is that the mechanism suggested here is one that not only gives rise to some of the broad features of the long boom regarding output, prices, employment, and productivity but one that is also consistent with the other economic story of the 1990's—a merger wave coupled with downsizing. Again, there is a reduction in the number of divisions or firms in which price competition is intensified. An obvious way for this to happen is by merger with each such consolidation accompanied by the laying off of overhead inputs. Of course, this is precisely what happened during the 1990's boom.

3b. Sensitivity Tests

A question remains as to how sensitive the results are to variations in the key parameter assumptions. Tables 2 through 6 attempt to address this issue by cataloguing how the economic outcomes change as the initial settings of the key parameters are altered over a range of 15 percentage points. Table 2 shows results of allowing for changes in the initial markup over marginal cost in Sector 1, with all other parameters at their

Table 2—Results as Initial Markup in Sector 1 Varies from 0.36 to 0.50

Initial Markup in Sector 1	Proportionate Change In Sector 2 Price	Proportionate Change In Nominal Wage	Proportionate Change In Sector 1 Price	Proportionate Change In Sector 2 Output	Proportionate Change In Real GDP	Proportionate Change In Total Employment
0.5	0.00854	0.00521	-0.09416	0.02993	0.02124	0.00661
0.49	0.00821	0.00490	-0.09307	0.02979	0.02116	0.00652
0.48	0.00788	0.00458	-0.09193	0.02966	0.02107	0.00641
0.47	0.00754	0.00426	-0.09078	0.02953	0.02097	0.00631
0.46	0.00720	0.00393	-0.08962	0.02939	0.02088	0.00620
0.45	0.00685	0.00360	-0.08845	0.02926	0.02078	0.00610
0.44	0.00650	0.00327	-0.08726	0.02912	0.02069	0.00599
0.43	0.00615	0.00293	-0.08605	0.02898	0.02059	0.00588
0.42	0.00579	0.00259	-0.08484	0.02884	0.02049	0.00577
0.41	0.00543	0.00224	-0.08361	0.02870	0.02039	0.00566
0.4	0.00507	0.00189	-0.08236	0.02856	0.02029	0.00555
0.39	0.00470	0.00154	-0.08110	0.02842	0.02018	0.00543
0.38	0.00432	0.00118	-0.07982	0.02827	0.02008	0.00532
0.37	0.00394	0.00082	-0.07853	0.02812	0.01997	0.00520
0.36	0.00356	0.00045	-0.07723	0.02797	0.01987	0.00508

baseline values. The range of variation is from $X = 0.36$ to $X = 0.50$, which includes the baseline case of $X = 0.43$ as a midpoint.

The results in Table 2 show that the higher the initial markup, the more the price in Sector 1 falls with the onset of price discrimination. Accordingly, the overall macroeconomic effects rise with the size of the initial

Sector 1 markup. However, the variation is not large. The rise in real gdp remains consistently close to the 2.0 percent value found in the baseline simulation. Similarly, factor productivity increases continue to hover near the 1.4 percent range. Because the higher initial markup implies a larger percentage fall in Sector 1's price, real wage increases are bit higher than previously. By and large, however, the baseline results are not terribly sensitive to alternative plausible choices of the initial level of the markup in Sector 1.

In Table3, I consider how the baseline results are altered as another key parameter in Sector 1—the fraction of its inputs (labor) that is initially overhead—is varied from a low of 13 percent to a high of 27 percent. These

Table 3—Results as Fraction of Overhead Inputs in Sector 1 Varies from 0.13 to 0.27

Fraction of Overhead Labor In Sector 1	Proportionate Change In Sector 2 Price	Proportionate Change In Nominal Wage	Proportionate Change In Sector 1 Price	Proportionate Change In Sector 2 Output	Proportionate Change In Real GDP	Proportionate Change In Total Employment
0.27	0.00074	-0.00328	-0.09037	0.03618	0.02568	0.00560
0.26	0.00151	-0.00239	-0.08978	0.03514	0.02496	0.00564
0.25	0.00229	-0.00150	-0.08916	0.03412	0.02423	0.00568
0.24	0.00306	-0.00062	-0.08854	0.03309	0.02350	0.00572
0.23	0.00383	0.00027	-0.08792	0.03206	0.02277	0.00576
0.22	0.00461	0.00116	-0.08730	0.03104	0.02205	0.00580
0.21	0.00538	0.00204	-0.08668	0.03001	0.02132	0.00584
0.2	0.00615	0.00293	-0.08605	0.02898	0.02059	0.00588
0.19	0.00692	0.00382	-0.08543	0.02796	0.01986	0.00592
0.18	0.00770	0.00471	-0.08481	0.02693	0.01913	0.00596
0.17	0.00847	0.00559	-0.08419	0.02590	0.01840	0.00600
0.16	0.00924	0.00648	-0.08357	0.02488	0.01767	0.00604
0.15	0.01002	0.00737	-0.08295	0.02385	0.01694	0.00608
0.14	0.01079	0.00825	-0.08233	0.02283	0.01622	0.00612
0.13	0.01156	0.00914	-0.08171	0.02180	0.01569	0.00616

results make clear that this *is* an important variable. A higher initial overhead fraction in Sector 1, implies that more inputs are released to Sector 2 following the outbreak of price discrimination, thereby facilitating expansion in that sector and moderating upward price pressures. Indeed, for sufficiently high values of μ , nominal wages fall, although real wages still rise. Real gdp growth rises or falls by about half a percentage point compared to the baseline case. Overall productivity is less affected and continues to show gains on the order of one percent. It is important to note though that the minimum impact on real gdp is still a healthy 1.6 percent. The outbreak of price discrimination thus still contributes an important part to real gdp growth even in this weakest case.

Table 4 displays the results as the relative importance of Sector 1 varies from 0.22 to 0.36, a range that again includes the baseline value of 0.29 at the center. In this simulation, as in the baseline case, I adjust all the parameters ϕ , θ , and λ , simultaneously. That is, the simulation reflects how the results change as the share of Sector 1 in total employment, national income, and the aggregate price index all vary from 0.22 to 0.36. As Table 4 shows, this variation has effects that are similar to but somewhat weaker than varying the fraction of resources in Sector 1 that are overhead. The weakest case scenario when $\phi = \theta = \lambda = 0.22$, still yields a sizeable rise in real gdp of 1.6 percent as a result of the outbreak of price discrimination. The strongest case scenario shows a gain as high as 2.6 percent. Aggregate productivity growth remains above one percent in all cases and rises as high 1.8 percent.

Table 4—Results as Relative Economic Weight on Sector 1 Varies from 0.22 to 0.36

Weight On Price Discriminating Sector	Proportionate Change In Sector 2 Price	Proportionate Change In Nominal Wage	Proportionate Change In Sector 1 Price	Proportionate Change In Sector 2 Output	Proportionate Change In Real GDP	Proportionate Change In Total Employment
0.36	0.00814	0.00370	-0.08552	0.03996	0.02558	0.00732
0.35	0.00784	0.00359	-0.08559	0.03823	0.02486	0.00711
0.34	0.00754	0.00348	-0.08567	0.03657	0.02415	0.00691
0.33	0.00725	0.00337	-0.08575	0.03497	0.02344	0.00670
0.32	0.00697	0.00326	-0.08583	0.03340	0.02272	0.00650
0.31	0.00669	0.00315	-0.08590	0.03189	0.02201	0.00629
0.3	0.00642	0.00304	-0.08598	0.03042	0.02130	0.00609
0.29	0.00615	0.00293	-0.08605	0.02898	0.02059	0.00588
0.28	0.00589	0.00282	-0.08613	0.02759	0.01988	0.00567
0.27	0.00563	0.00272	-0.08621	0.02624	0.01916	0.00547
0.26	0.00538	0.00261	-0.08628	0.02492	0.01845	0.00527
0.25	0.00513	0.00250	-0.08635	0.02364	0.01774	0.00506
0.24	0.00489	0.00240	-0.08643	0.02240	0.01703	0.00486
0.23	0.00465	0.00229	-0.08650	0.02118	0.01632	0.00465
0.22	0.00441	0.00219	-0.08658	0.02000	0.01561	0.00445

In Table 5 (next page), I turn to the key parameter in Sector 2, namely, that sector's degree of scale economies. While in principle this parameter could play an important role in the analysis, the baseline results remain relatively unchanged over the range of parameter values considered. To the extent that sector 2 enjoys nearly constant returns to scale ($\alpha=0.97$), the effects of the emergence of price discrimination in sector 1 are modestly larger. The rise in real gdp rises from the two percent baseline gain to 2.2 percent here.

When scale diseconomies are more pronounced ($\alpha=0.83$), the rise in real gdp declines slightly to 1.87 percent.

Table 5—Results as Output Elasticity in Sector Varies from 0.83 to 0.97

Elasticity of Output In Sector 2	Proportionate Change In Sector 2 Price	Proportionate Change In Nominal Wage	Proportionate Change In Sector 1 Price	Proportionate Change In Sector 2 Output	Proportionate Change In Real GDP	Proportionate Change In Total Employment
0.97	0.00349	0.00251	-0.08632	0.03178	0.02256	0.00627
0.96	0.00387	0.00257	-0.08631	0.03137	0.02228	0.00621
0.95	0.00426	0.00263	-0.08627	0.03096	0.02199	0.00616
0.94	0.00464	0.00269	-0.08622	0.03056	0.02171	0.00610
0.93	0.00502	0.00275	-0.08618	0.03017	0.02143	0.00604
0.92	0.00540	0.00281	-0.08614	0.02977	0.02115	0.00599
0.91	0.00578	0.00287	-0.08610	0.02938	0.02087	0.00593
0.9	0.00615	0.00293	-0.08605	0.02898	0.02059	0.00588
0.89	0.00653	0.00299	-0.08601	0.02859	0.02031	0.00583
0.88	0.00690	0.00305	-0.08597	0.02821	0.02004	0.00577
0.87	0.00727	0.00311	-0.08593	0.02782	0.01976	0.00572
0.86	0.00763	0.00317	-0.08589	0.02743	0.01949	0.00566
0.85	0.00800	0.00323	-0.08585	0.02705	0.01922	0.00561
0.84	0.00836	0.00328	-0.08581	0.02667	0.01895	0.00556
0.83	0.00873	0.00334	-0.08577	0.02629	0.01868	0.00550

Finally, in Table 6 (next page), I examine how the simulated results change as the elasticity of labor supply varies over the range, 0.18 to 0.32. Again, it bears repeating that the underlying model is quite simplified and that, in particular, labor is treated as the only input. Hence, the elasticity used here is really an elasticity that proxies for the supply of all inputs. In any event, variations in the elasticity parameter over the specified range have little material effect on the baseline results. Indeed, the range of real gdp increases is now narrowed to between two and 2.2 percent. Of course, the more elastic is the supply the less growth there is in nominal (and real) wages. Relatedly, greater elasticity leads to a lower increase in factor productivity. Even so, such productivity growth stays relatively constant at 1.5 percent.

It is important to remember that in all of the simulations, the outbreak of price discrimination is accompanied by a significant fall in the number of firms in Sector 1. Firms merge to become more efficiently shrinking the share of their inputs that are overhead and producing a greater volume. Such shrinking or downsizing releases inputs for use in Sector 2. More importantly, the simulations painted here give rise to a corporate merger wave of precisely the type that accompanied the long boom of the 1990's.

Table 6—Results as Labor Supply Elasticity Varies from 0.18 to 0.32

Labor Supply Elasticity	Proportionate Change In Sector 2 Price	Proportionate Change In Nominal Wage	Proportionate Change In Sector 1 Price	Proportionate Change In Sector 2 Output	Proportionate Change In Real GDP	Proportionate Change In Total Employment
0.32	0.00467	0.00123	-0.08724	0.03096	0.02198	0.00743
0.31	0.00488	0.00147	-0.08707	0.03067	0.02179	0.00721
0.3	0.00509	0.00171	-0.08691	0.03039	0.02159	0.00699
0.29	0.00530	0.00196	-0.08674	0.03011	0.02139	0.00677
0.28	0.00551	0.00220	-0.08657	0.02983	0.02119	0.00655
0.27	0.00573	0.00244	-0.08640	0.02955	0.02099	0.00633
0.26	0.00594	0.00269	-0.08623	0.02927	0.02079	0.00610
0.25	0.00615	0.00293	-0.08605	0.02898	0.02059	0.00588
0.24	0.00637	0.00318	-0.08588	0.02870	0.02039	0.00566
0.23	0.00658	0.00342	-0.08571	0.02841	0.02018	0.00543
0.22	0.00680	0.00367	-0.08554	0.02813	0.01998	0.00520
0.21	0.00701	0.00392	-0.08536	0.02784	0.01978	0.00498
0.2	0.00723	0.00417	-0.08519	0.02755	0.01957	0.00475
0.19	0.00745	0.00442	-0.08501	0.02726	0.01936	0.00452
0.18	0.00767	0.00467	-0.08484	0.02697	0.01916	0.00429

4. Summary and Conclusions

Price competition is a powerful force. It is also one that is greatly intensified by price discrimination.

When large-scale price discrimination is possible, each customer becomes a battlefield and firms are forced to compete aggressively.

This paper has explored the possibility that a rapid growth in the use of price discrimination techniques may have played an important part in the long boom of the 1990's. In particular, it has sought to examine whether and to what extent the role of the information technology revolution may have been to facilitate the gathering and processing of customer information as well as firms' ability to "version" their product all with in an effort to enhance discriminatory pricing. When this occurs in a sector characterized by scale economies, the intensified price competition reduces margins and forces firms to consolidate so as to move down their average cost curve. Prices fall both because of the intensified price competition and the more efficient production. This makes it possible to expand production throughout the economy. The downsizing that results from consolidation in the initial sector releases inputs that may be used elsewhere in the economy. In addition, the price decline raises real wages and induces additional labor supply.

The new information technology is important because a central requirement for implementation of price

discrimination techniques is, in fact, information. The ability to price or design (or both) precisely to meet individual customer preferences is greatly enhanced by the information available in the new economy.

Digital commerce is particularly amenable to the application of such tactics.

Simulation of a rough and ready model of the economy provides support for the hypothesis that the spread and increased sophistication of price discrimination techniques played an important role in the boom of the 1990's. The model yields growth in real output on the order of two percent and increases in total factor productivity on the order of one percent across a wide variety of parameter settings. Employment, real wages and profits also increase. The gdp growth result is equal to the lower bound estimate and one third of the upper bound estimate of the rise in potential gdp estimated by Oliner and Sichel (2000) and Jorgenson and Stiroh (2000). The rise in total factor productivity is very close to the estimates of these authors. In the context of the fixed nominal income framework assumed here, the rise in real gdp exerts an equal an opposite pressure on the price level. Hence, the model also helps to explain why inflation of the 1990's was moderate despite the output growth.

A further feature of the model is that it gives rise to a merger wave and downsizing as firms in the differentiated product industries consolidate and rationalize their production. Besides the unprecedented general expansion, this consolidation and rationalization is the other main economic story of the 1990's. The fact that this outcome is predicted by the model further supports the notion that intensified price competition had something to do with the 1990's boom, especially since many of these mega-mergers involved firms precisely in those industries (telecommunications, financial services, retail and wholesale trade) that were the largest purchasers of information technology capital.⁸

I do not wish to overstate the case or suggest that the model should be taken literally. The point is not to argue definitively that facilitating price discrimination and intensifying price competition *is* the way that information technology catalyzed the boom. Rather, my aim is to consider the conditions under which this might be the case. The largely exploratory exercise undertaken here suggests that the conditions are not that restrictive primarily because the fall in price margins that occurs when price discrimination breaks out is

⁸ See Bonds and Aylor (1998).

quite severe. Hence, even if the sector in which this happens is small and even if the economy overall does not enjoy scale economies, the impact of this intensification of price competition can be substantial. Moreover, focusing on price discrimination alone may understate the effect of computerization on price-cost margins because, as noted, computers and the Internet also facilitate comparison shopping which may lower consumer taste for variety t , which again results in a lower margin. Such considerations and the evidence presented in this paper do in fact, suggest that an important—but not the only reason—for the long boom of the 1990's was an outbreak of competition. In this connection, note too that while this development may be regarded as a healthy one there is a downside. To the extent that the role of information technology has been to intensify such competition rather than to shift the production function, these gains are a one-time phenomenon. That is, they do not reflect a permanent increase in the growth rate of potential gdp.

References

- Altonji, J., "Intertemporal Substitution in Labor Supply: Evidence from Micro Data". *Journal of Political Economy*, (May, 1986), 176-215.
- Bailey, M. N., C. Hulten, and D. Campbell. "Productivity Dynamics in Manufacturing Plants." *Brookings Papers on Economic Activity: Microeconomics*, (1992), 187-249.
- Basu, S. "Intermediate Goods and Business Cycles: Implications for Productivity and Welfare". *American Economic Review*, 85 (June, 1991), 512-31.
- Blundell, R. and T. E. MaCurdy, "Labor Supply: A Review of Alternative Approaches" in O. Aschenfelter and D. Card, eds. *Handbook of Labor Economics*, Elsevier: Amsterdam (1999).
- Bonds, B. and T. Aylor, "Investment in New Structures and Equipment in 1992 By Using Industries." *Survey of Current Business*, 78 (December, 1998), 26-51.
- Bosworth, B. and J. E. Triplett. "'Baumol's Disease' Has Been Cured: IT and Multifactor Productivity in U.S. Service Industries." in D. Jansen, *The New Economy. How New? How Resilient?* Chicago: University of Chicago Press, (forthcoming 2004).
- Brynjolfsson, E. and L. Hitt, "Computing Productivity: Firm Level Evidence". *Review of Economics and Statistics*, 85 (November, 2003), 793-808.

Burnside, C., M. Eichenbaum, and S. Rebelo. "Capital Utilization and Returns to Scale". In B. S. Bernanke and J. J. Rotemberg, eds., *NBER Macroeconomics Annual, 1995*. Cambridge: MIT Press, (1995),

Domowitz, I., G. Hubbard, and B. Petersen, "Market Structure and Cyclical Fluctuations in U.S. Manufacturing". *Review of Economics and Statistics*, 70 (February, 1988), 55-66.

Hall, R., "The Relation Between Price and Marginal Cost in U.S. Industry", *Journal of Political Economy*, 96 (October, 1988), 921-47.

Jorgenson, D. W. and K. J. Stiroh, "Raising the Speed Limit: U.S. Economic Growth in the Information Age". *Brookings Papers on Economic Activity*, (2000) (1), 125-211.

MaCurdy, T. E., "An Empirical Model of Labor Supply in a Life-Cycle Setting". *Journal of Political Economy*, 89 (November, 1981), 1059-85.

Norman, G. and J. Thisse, "Product Variety and Welfare Under Soft and Tough Pricing Regimes". *Economic Journal*, 106 (January, 1996), 76-91.

Oliner, S. D. and D. E. Sichel, "The Resurgence of Growth in the Late 1990's: Is Information Technology the Story?" *Journal of Economic Perspectives*, 14 (Fall, 2000), 3-22.

Rangan, S. and R. Z. Lawrence, *A Prism on Globalization: Corporate Responses to the Dollar*, Brookings Institute: Washington, D.C., (1999).

Rogerson, W. "Overhead Allocation and Incentives for Cost Minimization in Defense Procurement" *The Accounting Review*, 67 (October, 1992), 671-90.

Salop, S. "Monopolistic Competition with Outside Goods." *Bell Journal of Economics*, 10 (Spring, 1979), 345-56.

Shapiro, C. and H. Varian, *Information Rules*. Boston: Harvard Business School Press, (1999).

WORKING PAPER SERIES 2004

ase.tufts.edu/econ/papers

- 2004-01** EGGLESTON, Karen & Winnie Yipp; Hospital Competition under Regulated Prices: Application to Urban Health Sector Reforms in China
- 2004-02** EGGLESTON, Karen & Chee-Ruey Hsieh; Health Care Payment Incentives: A Comparative Analysis of Reforms in Taiwan, Korea and China
- 2004-03** EGGLESTON, Karen; Competition, Altruism, and Provider Payment
- 2004-04** LOURY, Linda; Some Job Contacts are More Equal Than Others: Earnings and Job Information Networks
- 2004-05** LOURY, Linda; Teen Childbearing and Community Religiosity
- 2004-06** LOURY, Linda; Religiosity and High School Misbehavior
- 2004-07** MUKAND, Sharun & Sumon Majumdar; Policy Gambles
- 2004-08** MUKAND, Sharun & Sanjay Jain; Public Opinion and the Dynamics of Reform
- 2004-09** MUKAND, Sharun, Sumon Majumdar & Anandi Mani; Politics, Information and the Urban Bias
- 2004-10** BIANCONI, Marcelo; Aggregate and Idiosyncratic Risk and the Behavior of Individual Preferences under Moral Hazard
- 2004-11** BIANCONI, Marcelo; Transfer Programs and Consumption under Alternative Insurance Schemes and Liquidity Constraints

- 2004-12** BIANCONI, Marcelo; Heterogeneity, Adverse Selection and Valuation with Endogenous Labor Supply
- 2004-13** BIANCONI, Marcelo; The Welfare Gains from Stabilization in a Stochastically Growing Economy with Idiosyncratic Shocks and Flexible Labor Supply
- 2004-14** SHIMSHACK, Jay P. and Michael B. Ward; Enforcement and Environmental Compliance: A Statistical Analysis of the Pulp and Paper Industry
- 2004-15** NORMAN, George and Joel P. Trachtman; The Customary International Law Supergame: Order and Law
- 2004-16** BROWN, Drusilla K. and George Norman; Optimal Intellectual Property Rights Protection and Humanitarian Assistance during and International Health Emergency
- 2004-17** LOURY, Linda; Job Tenure and Personal Contacts: Good Matches or Limited Choices?
- 2004-18** KUTSOATI, Edward and Sharun Mukand; Expectations and the Central Banker: Making Decisions the Market Expects to See?
- 2004-19** RICHARDS, Daniel; Price Discrimination and the Long Boom.
- 2004-20** HARDMAN, Anna and Yannis Ioannides; Income Mixing and Housing in U.S. Cities: Evidence From Neighborhood Clusters of the American Housing Survey.
- 2004-21** HARDMAN, Anna and Yannis Ioannides; Neighbors' Income Distribution: Economic Segregation and Mixing in US Urban Neighborhoods. [revised]
- 2004-22** EGGERS Andrew and Yannis Ioannides; The Role of Output Composition in the Stabilization of the U.S. Output Growth
- 2004-23** SHIMSHACK Jay; Are Mercury Advisories Effective? Information, Education, and Fish Consumption.