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AMBULATORY & INPATIENT HEALTHCARE: 1998-2005**

David Hartzband

**Engineering Systems Division
Massachusetts Institute of Technology
dhartz@mit.edu**

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A Comparison of GDP-Based Productivity in Ambulatory & Inpatient Healthcare: 1998-2005¹

David Hartzband

Visiting Scholar, Engineering Systems Division
Massachusetts Institute of Technology
77 Massachusetts Avenue (E40-264)
Cambridge, MA 02139-4307
Email: dhartz@mit.edu
Phone: 617-324-6693 (MIT office)

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1 Abstract A comparison of GDP-based productivity in the ambulatory and inpatient (hospitals and residential treatment centers) healthcare segments shows that labor productivity, measured as GDP dollar contribution per compensation dollars, hours worked and full-time equivalent employees was strong in both actual value and in per cent gain (1998-2005). The actual values were higher in ambulatory with GDP contribution per hours worked ranging from \$0.04-\$0.06 (24% gain), per dollar of compensation ranging from \$1.41 to \$1.48 (4% gain) and per FTE from \$71,000 to \$94,000 (25% gain) as opposed to \$0.02 to \$0.03 (3% gain), \$1.10 to \$1.13 (3% gain) and \$38,000 to \$52,000 (42% gain) for inpatient healthcare. In contrast, capital efficiency was static for both segments over this period indicating that the use of capital was ineffective. Total Factor Productivity (TFP) was also calculated and showed a similar pattern with ambulatory healthcare having higher TFP throughout the period, but neither healthcare segment showing any gain (or loss) in TFP. The two segments have different profiles for the factors influencing TFP with inpatient healthcare having made both some R&D and substantial technology investments, mainly in medical devices. Neither segment has made large organizational or work process changes, and it appears that substantial, additional productivity gains could be made as these factors, R&D investment, technology acquisition and adoption, work process and organizational redesign, are emphasized.

2 Introduction: You have only to read your local paper today to get someone's idea of how dysfunctional our healthcare system is. Popular opinion, and in some cases the opinion of specialists in healthcare economics and policy, appears to be that our system is ineffective and wasteful. Certainly it has much room for improvement. One area of potential improvement that has been little focused on is the labor productivity and capital efficiency of the various segments of the healthcare industry. What work has been done, has generally found that labor productivity in several healthcare segments is low and has decreased over some recent time periods². A recent analysis³ of Gross Domestic Product (GDP) based productivity measures in

¹ I would like to acknowledge the support of the RCHN Community Health Foundation and especially of the Foundation's Executive Vice President, Feygele Jacobs

² Cromwell, J. 1987.

³ Hartzband, D.J. 2008

ambulatory healthcare showed, however, that GDP contribution in ambulatory healthcare increased by +38% from 1998 to 2005, and that labor productivity measured as GDP contribution scaled by total hours worked increased +24% in the same time period. This compared with GDP contributions of -14% and +16% in auto and information industries respectively and labor productivity of +6% and +33% for the same industries. This shows that ambulatory healthcare (outpatient health centers and clinics of many types) made substantial increases in both output (GDP contribution) and labor productivity from 1998 to 2005 that was intermediate between two benchmark industries: auto and information.

Further analysis found that capital efficiency, measured as gross output scaled by inputs, did not improve over the time period. The study also found a strong linkage between changes in gross domestic product components for value-added, gross output and both labor and capital inputs in ambulatory healthcare. This linkage was not found in either of the other two industry segments investigated. This linkage implies that labor and capital input account for close to all of the productivity gains measured in ambulatory healthcare, but that other factors, such as labor quality, work process and structural reorganization, research and development investment and adoption of new technologies are not affecting this gain in productivity the way they may be in the auto and information industry.

One of the ways to test this hypothesis is to determine if the same type of linkage exists in a similar industry known to have addressed at least some of the multiple factors not addressed in ambulatory healthcare. Analysis of such results will allow comparisons to be made across the industries and possibly to allow some recommendations for further improvements to be made. The calculation of total factor productivity would additionally serve to test this hypothesis and allow for deeper analysis. This study will compare labor productivity and capital efficiency, as well as total factor productivity, in ambulatory healthcare with inpatient (hospitals and other inpatient treatment centers) healthcare from 1998 to 2005.

Of course, the real goal of any healthcare improvement work is the improvement of clinical outcomes and quality of care. It is not clear that gains in labor productivity or capital efficiency improve outcomes or care quality, as these measures are indicators of how effectively labor and capital produce value. Total factor productivity, however, does address factors that could (and should) affect outcome and quality. The author plans additional work to investigate and report on the relationship between productivity, clinical outcomes and quality of care, with an emphasis on ambulatory healthcare.

3 Methodology: Labor and production productivity measures are calculated for two NAICS industry categories: Ambulatory Healthcare (NAICS 6210) and Hospitals and other Residential Care Facilities (NAICS 622, 623), here called Inpatient Healthcare, using Bureau of Economic Analysis (U.S. Department of Commerce) GDP component figures for the years 1998-2005)⁴.

Measures included:

⁴ <http://www.bea.gov/national/index.htm#gdp>

- Increase or decrease in percent GDP contribution
- Gross Output scaled by Intermediate Input – a measure of capital efficiency that indicates dollar amount of gross output, defined as sales, or receipts, and other operating income, plus commodity taxes and changes in inventories, scaled by intermediate input, defined as goods and services used in the production of other goods and services but not sold in final demand markets
- GDP value-added scaled by industry segment compensation – a measure of labor productivity, dollar amount of GDP contribution per dollar of compensation
- GDP value-added scaled by hours worked by full-time equivalent employees (BEA for GDP component data, BLS for hours worked data) – another measure of labor productivity, dollar amount of GDP contribution per hour worked
- Range of value-added over full-time equivalent employee – determines the GDP contribution of each full time employee
- Total factor productivity measured as in Diewert & Nakamura⁵ using BEA figures for GDP components.

Calculations of productivity measurements are made using raw BEA and BLS data. Calculations were also done according to the BLS indexed formulas⁶ using 2000 as the index year. This paper reports the raw data calculations as the actual figures obtained are easier to compare across industry segments than indexes. The percentages of loss or gain that the analysis is based on are the same for both raw and indexed calculations.⁷

In addition, BEA values for per cent of GDP contribution as well as chained quantity and price indices for GDP value-added, gross output and intermediate input were used to calculate per cent increase or decrease of each measure over the eight year time period.

Appendix A provides formulas for calculation of the productivity measures used in this study.

4 Results: The following tables provide labor and production productivity results by year and for overall percentages for the Ambulatory and Inpatient Healthcare NAICS categories as described above.

⁵ Diewert, w.e. and A.O. Nakamura. 2002

⁶ http://www.bls.gov/opub/hom/homch11_b.htm#Labor%20Productivity%20Measures

⁷ Results of indexed productivity calculations are available from the author.

Year	VA/Hours Worked \$	VA/Comp \$	VA/FTE \$/FTE	Gross Output/Input \$	Total Factor Productivity \$
1998	\$0.04389	1.42	70,660	3.12	3.14
1999	\$0.04532	1.42	72,740	3.12	3.11
2000	\$0.04745	1.41	76,390	3.14	3.14
2001	\$0.05062	1.44	81,750	3.25	3.17
2002	\$0.05241	1.45	84,910	3.22	3.13
2003	\$0.05411	1.46	87,390	3.17	3.09
2004	\$0.05559	1.46	90,050	3.10	3.03
2005	\$0.05742	1.48	93,590	3.13	3.14
Percent +/-	23.6	3.9	24.5	<1	<-1

Table 1. Labor & Production Productivity Measures for Ambulatory Healthcare (NAICS 6210), 1998-2005

Year	VA/Hours Worked \$	VA/Comp \$	VA/FTE \$/FTE	Gross Output/Input \$M	Total Factor Productivity \$
1998	\$0.02233	1.10	38,066	2.26	1.26
1999	\$0.02324	1.10	39,280	2.25	1.25
2000	\$0.02392	1.10	40,780	2.25	1.25
2001	\$0.02458	1.11	41,940	2.25	1.25
2002	\$0.02594	1.11	44,480	2.24	1.25
2003	\$0.02718	1.12	47,300	2.28	1.28
2004	\$0.02853	1.13	50,22	2.33	1.33
2005	\$0.02894	1.13	51,800	2.25	1.25
Percent +/-	22.9	2.7	42.0	<-1	<-1

Table 2. Labor & Production Productivity Measures for Inpatient and Residential Healthcare (NAICS 622, 623), 1998-2005

Industry Segment	% GDP Contribution	GO/ Input % 98-05	VA/ Comp % 98-05	VA/ Hours Worked % 98-05	VA/FTE \$/FTE Range	% Total Factor Productivity Change
Ambulatory Healthcare	11	<1	4	24	71,000-94,000	<-1
Inpatient and Residential healthcare	11	<1	3	23	30,000-52,000	<-1

Table 3. Summary of Percent Increase or Decrease for Productivity In Healthcare Industry Segments, 1998-2005

Industry Segment	% Value Added Trend	% Price Index Trend VA	% Gross Output Trend	% Price Index Trend GO	% Intermediate Input Trend	% Price Index Trend II
Ambulatory Healthcare	37.5	14.8	37.4	14.7	37.1	14.3
Hospitals and Residential Healthcare	37.3	30.1	37.4	23	37.6	13

Table 4. Summary of Quantity & Cost Trends for GDP Components in Healthcare Industry Segments, 1998-2005

5 Analysis & Discussion: The measures of labor productivity and capital efficiency used in this study are gross, but they are more than sufficient to identify and analyze trends in productivity in these industries.

In ambulatory healthcare, value-added or amount of GDP contribution per hour worked ranged from 4.4 to almost 6 cents per hour which represented a 24% gain over the time period analyzed. Each dollar of compensation produced \$1.42 to \$1.48 of value-add (4% increase), and each full-time equivalent employee represented between \$71K and \$94K in value-add for a 25% increase. Labor productivity was strong during the 1998-2005 time period, as indicated by these measurements. In contrast, capital efficiency as measured by the ratio of gross output to intermediate inputs was static increasing by less than 1%, although it varied between \$3.12 and \$3.25 of gross output for each dollar of intermediate input.

The pattern for these measures is similar for inpatient healthcare, although it is striking that this segment was much less efficient than ambulatory healthcare. Value-add per hour worked ranged from 2.2 to 2.9 cents per hour for a 23% gain. Each dollar of compensation produced \$1.10 to \$1.13 dollars of value-add (3% gain), and each full-time employee equivalent represented between \$38K and \$52K for a 42% increase. Capital efficiency varied between \$2.22 and \$2.28 and was also essentially static (<1% loss) for the 1998-2005 time period.

The most interesting trends are in the cross-industry comparisons. As already mentioned, ambulatory healthcare appears to have higher labor productivity in both value-added per hours worked and per full-time equivalent employee. Capital efficiency is comparatively good in both segments with Gross Output averaging 3.2 times as large as Intermediate Inputs for Ambulatory and 2.3 times as large for Inpatient. The problem is that capital efficiency shows no gain during this time period for either healthcare segment. Figure 1 shows quantity and price trends in productivity for these segments and begins to provide some insight into this lack of change in capital efficiency.

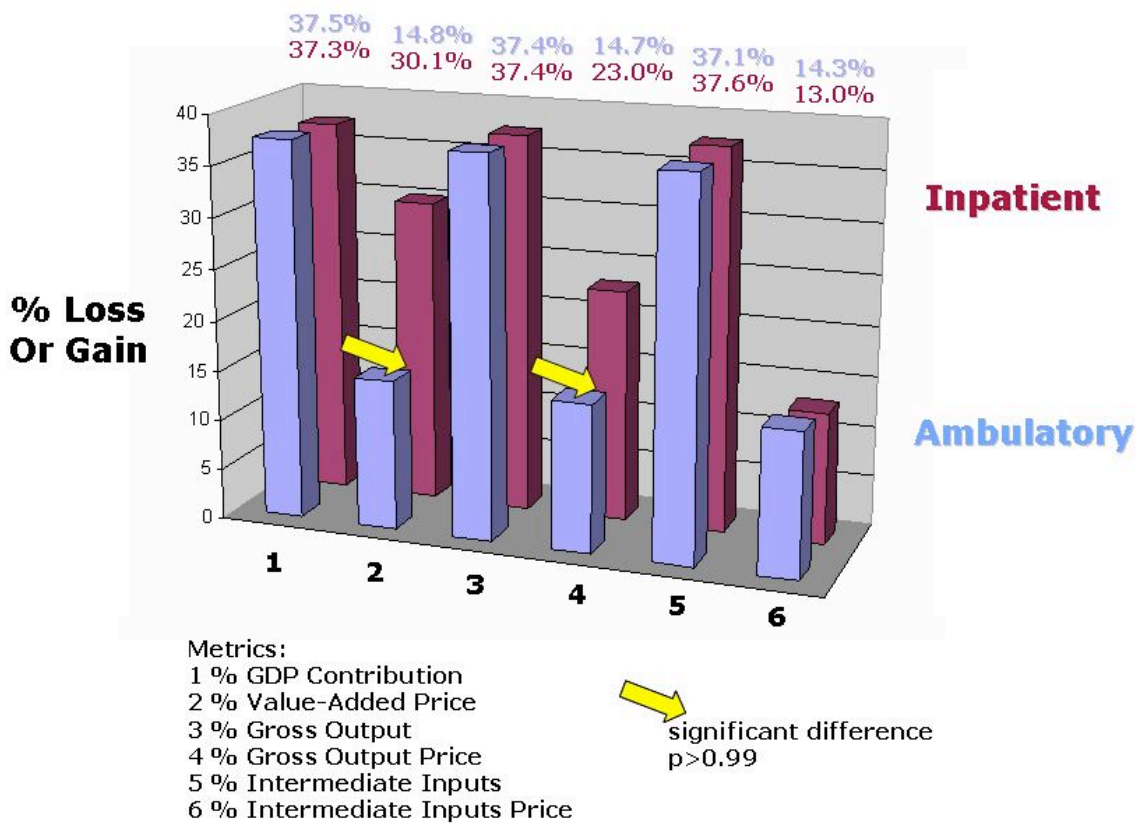


Figure 1. Productivity Quantity & Price Trend Metrics, GDP Data 1998-2005

It is clear that the quantity and price trends for Ambulatory Healthcare show strong linkage. These trends vary between ~37% gain for value-added contribution, gross output and intermediate inputs; and ~14% gain for the respective price trends for

each metric. This uniformity in quantity and price trends indicates that the majority of the increase in each metric can be attributed to the observed increases in labor and capital input during this period, and not to other factors (see below for a discussion of total factor productivity measurements).

This linkage was not found in the Inpatient Healthcare trends, in fact the cost to produce both value-add (GDP contribution) and gross output was much higher for the inpatient segment. The per cent gain in cost over the time period was also much higher at 30% for GDP contribution and 23% for gross output, as opposed to 15% for both components in Ambulatory.

Comparison of total factor productivity shows a similar pattern. TFP in Ambulatory Healthcare ranged from \$3.03 to \$3.17 in cost adjusted value-added per dollar spent. In Inpatient Healthcare this range was \$1.25 to \$1.33. In both cases, there was no gain in TFP over this time period.

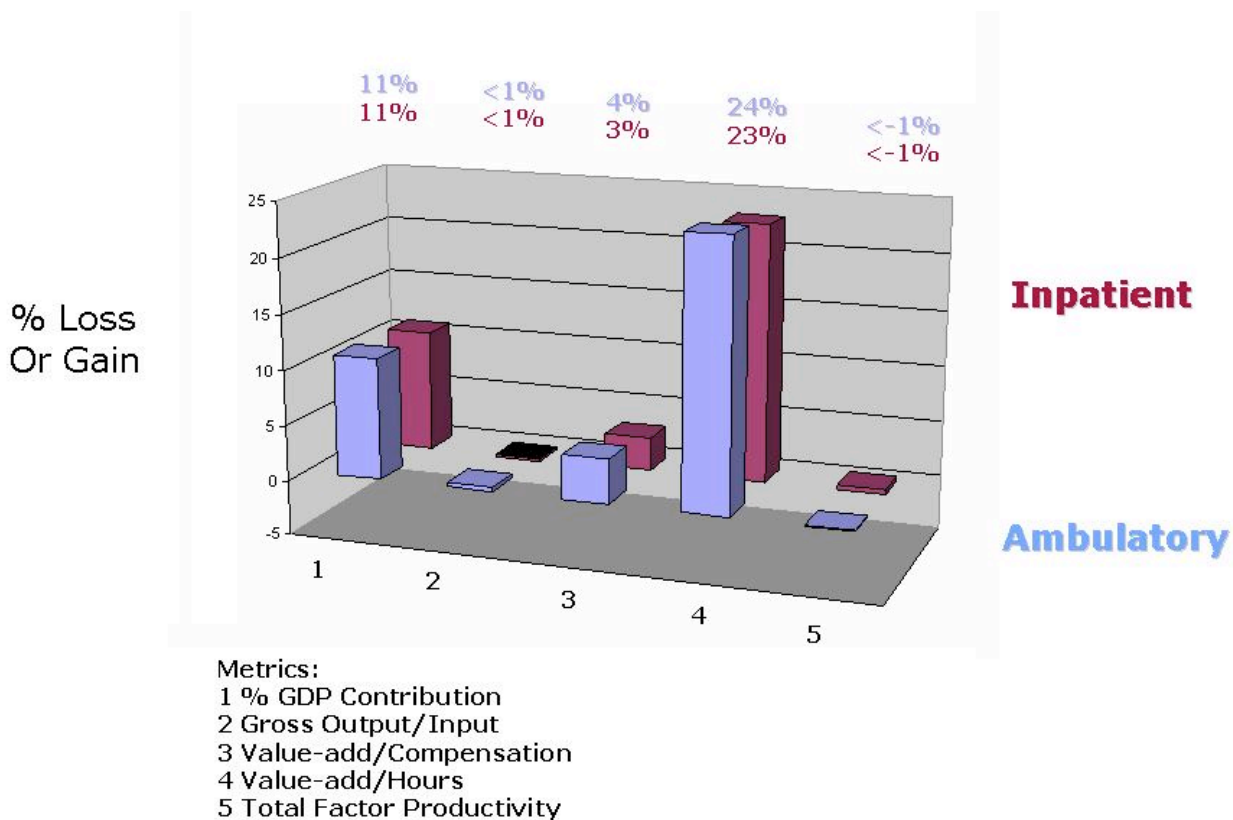


Figure 2. GDP Productivity Measures, Ambulatory and Inpatient Healthcare: 1998-2005

The difference here is, as shown in Figure 1, the GDP contribution for inpatient healthcare costs more to produce. Total Factor Productivity (TFP) is defined as any effects in total output not caused by capital inputs or labor productivity. TFP generally represents effects related to changes in how workplaces are organized and

managed⁸. We also know that total factor productivity reflects not just labor and capital factors but also research and development investment and adoption of new technologies⁹. The relatively high level of TFP, especially in ambulatory healthcare, reflects the effectiveness of labor and capital inputs. The lack of any gain in TFP, in either healthcare segment reflects the fact that little organizational or workflow change has taken place, and that there has been little successful R&D investment and/or technology adoption, despite the money that has poured into these segments in recent years. This is especially true in inpatient healthcare where the cost of GDP production not linked to labor productivity has increased substantially, but no gain in TFP has occurred (<1% loss, 1998-2005). The implication is that there is a huge opportunity for R&D investment, technology adoption, organizational & workflow redesign in both ambulatory and inpatient healthcare that could potentially improve productivity in these segments much more than the gains from labor & capital investment have over this time period.

⁸ **Baily, M.N.** 2004.

⁹ **Brynjolfsson, E., L. M. Hitt & Y. Shinkyu.** 2002.

6 Appendix A: Definitions and formulas for calculating productivity measures:

Definitions:

1. ambulatory healthcare – industries that provide health care services directly or indirectly to ambulatory patients and do not usually provide inpatient services. Health practitioners in this subsector provide outpatient services, with the facilities and equipment not usually being the most significant part of the production process¹⁰
2. value added – the corrected (2005 revision) contribution of a NAICS industry segment to the gross domestic product. All values from Bureau of Economic Analysis figures (in millions of dollars, current)
3. hours worked – the estimated hours worked by NAICS industry segment from the Bureau of Labor Statistics figures (in hours per time period)
4. compensation – the estimated compensation (sum of wages and salaries and supplements) paid to employees in a NAICS industry segment for a specific time period (in millions of dollars, current)
5. gross output - the sales, or receipts, and other operating income, plus commodity taxes and changes in inventories of a NAICS industry segment for a specific time period (in millions of dollars, current)
6. intermediate inputs – the goods and services that are used in the production process of other goods and services for a specific NAICS industry segment and are not sold in final-demand markets (in millions of dollars, current)

Formulas:

1. $VA/H = VA_{tx} / (H_{tx} \times 1000)$, VA in \$m, H in 1000s, VA/H in \$M
2. $VA/C = VA_{tx} / C_{tx}$, VA in \$m, C in \$M, VA/C in \$M
3. $VA/FTE = VA_{tx} / (FTE_{tx} \times 1000)$ VA in \$M, FTE in 1000s, VA/FTE in \$
4. $GO/Input = GO_{tx} / Input_{tx}$ GO in \$M, Input in \$M GO/Input in \$M

Indexed productivity measurements were calculated to compare with the Bureau of Labor Statistics measurements as follows:

5. $(V_a/V_0)/(L_a/L_0) = P$, where V_a equals value output in year a, V_0 equals the value output in the index year, L_a equals labor input in year a & L_0 equals labor input in the index year

Value inputs used include BEA value-added (GDP contribution) & BEA gross output, labor inputs used include BLS hours worked, BEA compensation, BEA full-time equivalent employees & BEA intermediate input.

6. **PerCent Change = $100 - (Comp_{t_1} / Comp_{t_x}) \times 100$** – where Comp is the value of a GDP component at t_1 and t_x

7. Total Factor Productivity

¹⁰ North American Industry Classification System (NAICS) 1997 definition of NAICS class 621, ambulatory healthcare, Department of Commerce, <http://www.census.gov/epcd/naics/NDEF621.HTM>

$[(1+R_{t1}/C_{t1})/(1+R_{tx}/C_{tx})]/(P_C/P_R)$ – where R is revenue, C is cost and P is price

7 References

Baily, M.N. 2004 Recent Productivity Growth: The Role of Information Technology and other Innovations. Federal Reserve Bank of San Francisco Economic Review. pp 34-42.

Brynjolfsson, E., L. M. Hitt & Y. Shinkyu. 2002. Intangible Assets: Computers & Organizational Capital. Brookings Papers on Economic Activity. Macroeconomics (1): 137-199.

Cromwell, J. 1987. Trends in Hospital Labor and Total Factor Productivity, 1981-1986. Health Care Financial Review. Summer 1987

Diewert, W.E and A.O. Nakamura. 2002. The Measurement of Aggregate Total Factor Productivity Growth. in Heckman, J.J. and E.E Leamer. 2003. Handbook of Econometrics. Elsevier.

Hartzband, D.J. 2008. GDP-Based Productivity in Ambulatory Healthcare: A Comparison with Other Industries, 1998-2005. ESD Working Paper 2008-11, MIT, revised version submitted to Health Affairs