

INFORMATION TECHNOLOGY AND PRODUCTIVITY: RECENT FINDINGS

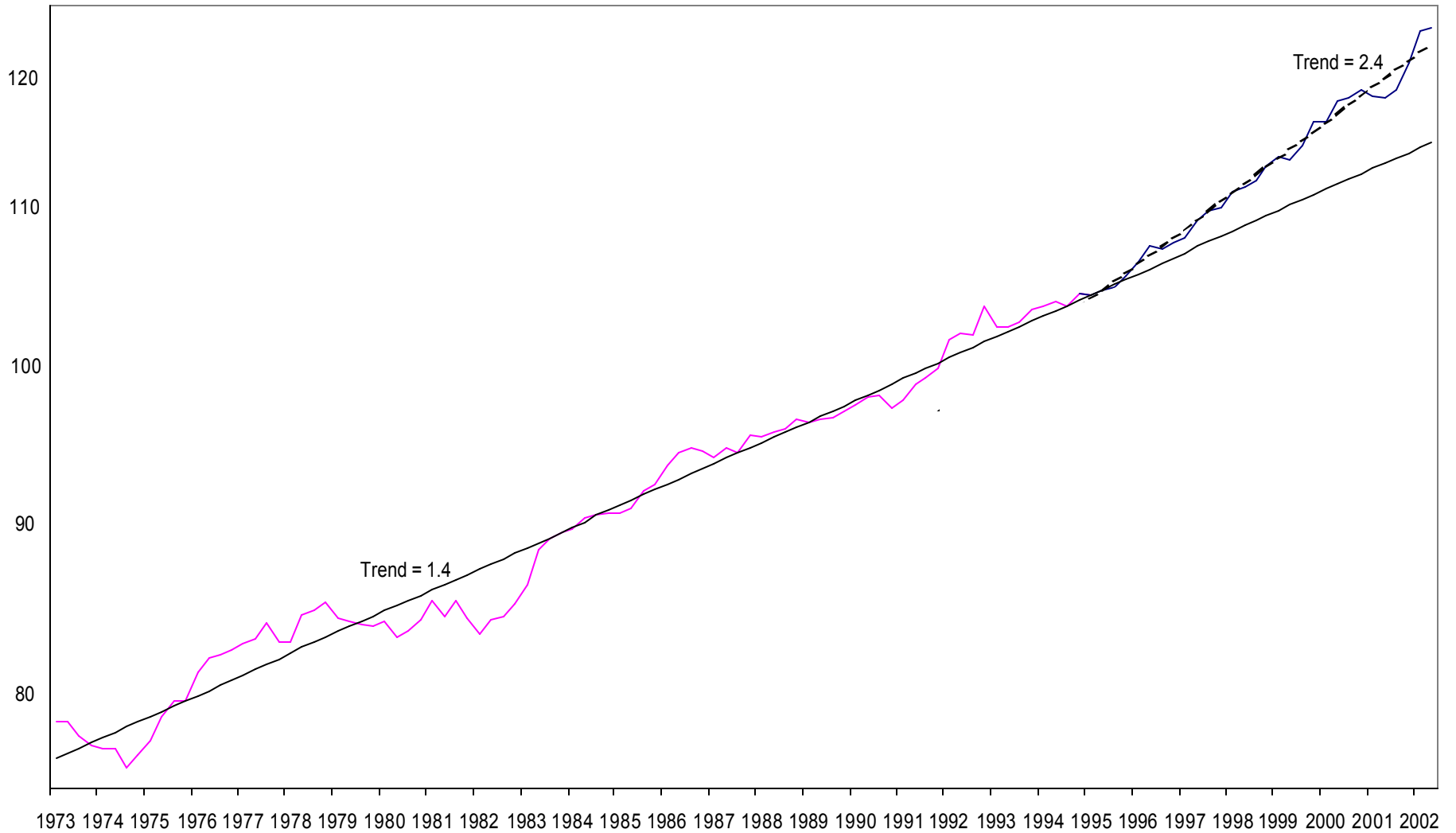
Presentation at the AEA Meetings
January 3, 2003

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Despite data revisions, the productivity acceleration remains important

Index 1992 = 100

Nonfarm Business Productivity

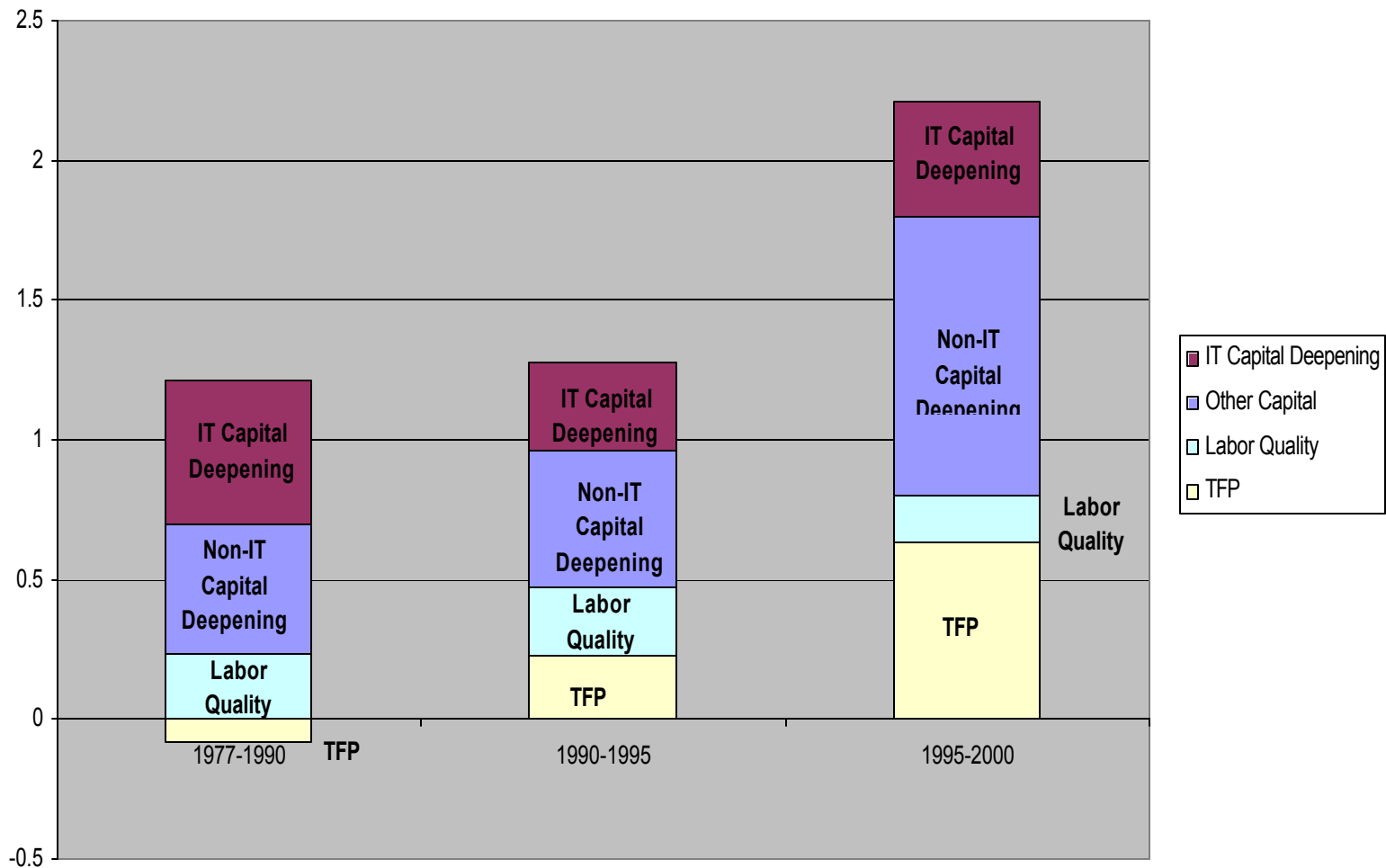


Source: Bureau of Labor Statistics. Index on logarithmic scale.

- Aggregate growth accounting estimates of the sources of the productivity acceleration indicate that both capital deepening and TFP have driven the acceleration.
- Faster capital deepening is associated with IT capital.
- Jorgenson-Ho-Stiroh find faster TFP growth in the 1990s compared to 1977-90. Some of this is from the IT-producing sector, but some is from a shift from negative to positive TFP growth in the IT-using sector.
- Oliner and Sichel attribute almost all of the acceleration to IT capital and TFP in the IT-producing sector.

Sources of US Labor Productivity Growth

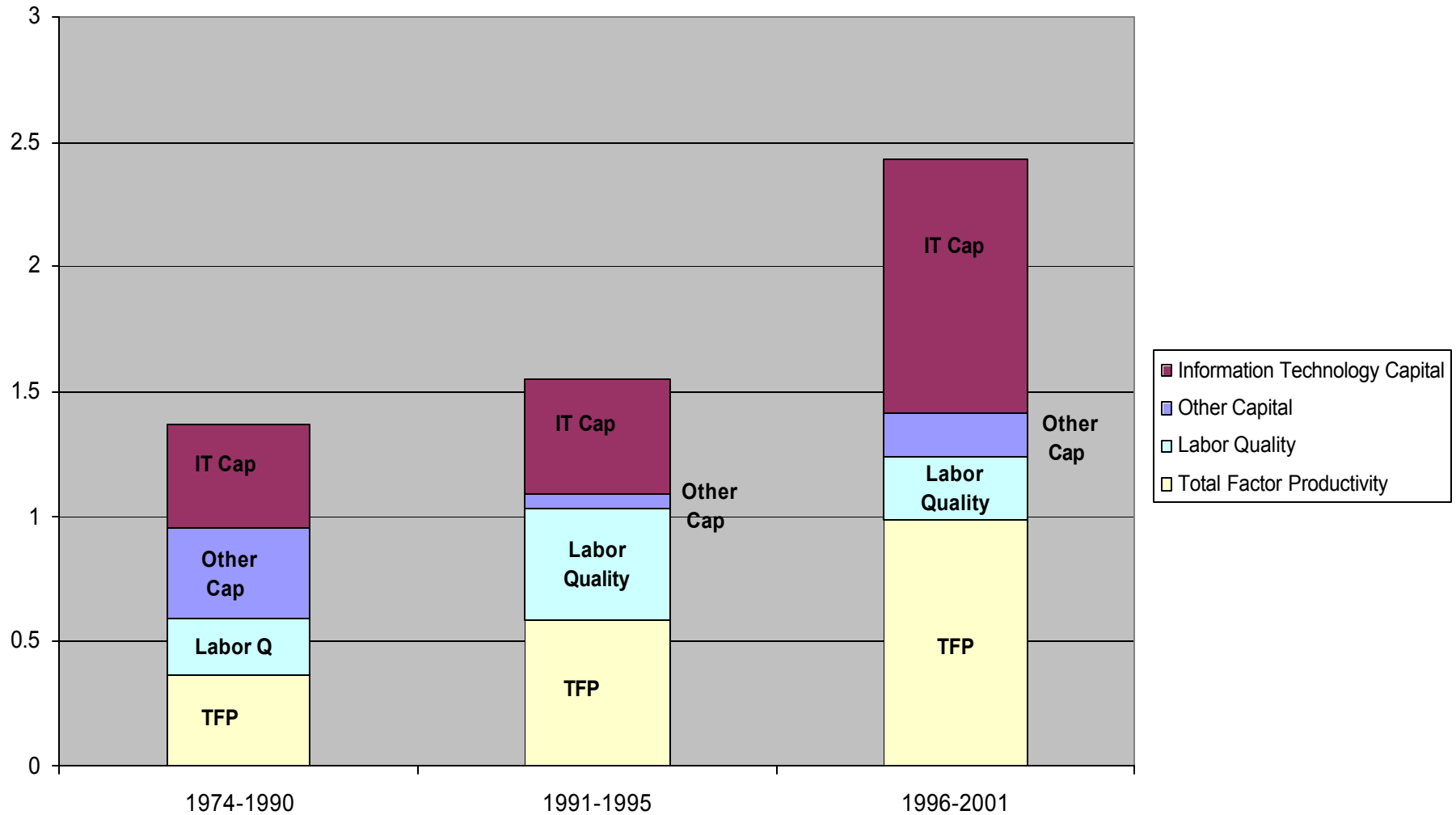
Jorgenson-Ho-Stiroh



Source: "Growth of U.S. Industries and Investments in Information Technology and Higher Education,"
<http://post.economics.harvard.edu/faculty/jorgenson/papers/papers.html>

Sources of US Labor Productivity Growth

Oliner-Sichel



Source: "Information Technology and Productivity: Where Are We Now and Where Are We Going?"

<http://www.federalreserve.gov>; under Economic Research

- The slowdown in productivity growth in the 1970s was associated with a collapse of labor and total factor productivity growth in services.
- The post-1995 acceleration has reversed the service sector slowdown.
- Triplett and Bosworth find that this recovery in services was driven by more rapid TFP growth after 1995, not by a larger contribution of IT capital. IT capital made an important contribution both before and after 1995.

Brookings, September 18, 2002

- Growth accounting estimates cannot show the existence or direction of causality.
- The hedonic deflators may result in an overestimate of the contribution of IT capital.
- Case study analysis by the McKinsey Global Institute concluded that business innovation, driven by competitive pressure, caused the acceleration. Some innovations were IT related, others were not:
 - Large-scale (big-box) retail stores are more productive
 - Downward pressure on prices forced operational improvements and lean production
- Many expensive IT efforts failed to pay-off:
 - CRM (customer relations management) software yielded few measurable benefits in hotels.
 - Installing more powerful desktop computers provided no improvement in usable capability in banking.
 - Y2K upgrades were necessary but did not always improve performance.
 - ERP software can reduce flexibility and inhibit innovation.

- Analysis of establishment and firm data in retail reinforce the view that competitive pressure forces productivity increase.

“Our results show that virtually all of the productivity growth in the U.S. retail trade sector over the 1990s is accounted for by more productive entering establishments displacing less productive exiting establishments. Interestingly, much of the between establishment reallocation is a within, rather than between firm phenomenon.”

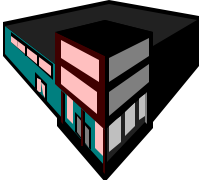

Foster, Haltiwanger and Krizan

NBER Working Paper 9120

- IT contributed to industry restructuring, but computerizing existing establishments was not the main source of productivity increase.

- *How IT Enables Productivity Growth*, a new study by the McKinsey Global Institute, explores the ways in which IT raised labor productivity in the 1990s.
 - The study did not focus on the acceleration and did not attempt to estimate what proportion of growth was due to IT
 - A robust conclusion was that IT only contributes to productivity growth when accompanied by business process innovation
 - The way IT contributes to productivity is very different across industries and even sub sectors
 - This means IT applications have to be tailored to sector-specific business processes and linked to performance measures
 - Successful IT applications are deployed in a sequence that builds capabilities
 - This means that business process innovations and new IT applications should evolve together

IT APPLICATIONS IN RETAIL CAN EVEN VARY BY SUBSECTOR AND BUSINESS MODEL

Subsector	Business model	Impact of IT applications
 GMS	<ul style="list-style-type: none"> • Every Day Low Price retailer (e.g., Wal-Mart) • High-/low-pricing retailer (e.g., Sears, Kmart) • Department stores (e.g., May, Federated) 	<ul style="list-style-type: none"> • Improved distribution/logistics and inventory visibility improves operational effectiveness, thereby reducing costs • Promotions/campaign management tools needed to determine and monitor promotional effectiveness • In-store apps (e.g., labor scheduling) need to support promotions • Inventory visibility and enhanced merchandise allocation tools needed to reduce lead times and markdowns for their low-volume, high-margin items (e.g., apparel)
 Apparel	<ul style="list-style-type: none"> • Vertically integrated specialty apparel provider (e.g., Gap, The Limited) • Apparel discounter (e.g., Ross) • Catalog players (e.g., Spiegel) • High-end retailers (e.g., Neiman Marcus, Saks) 	<ul style="list-style-type: none"> • Vendor management systems have highest impact by shortening time to market and improving production/sourcing • Optimum pricing and markdowns in stores drive firm's top line • CRM seeks revenue/margin optimization • Customer data warehouse allows microclustering of customers for targeted promotions to increase up-sell/cross-sell opportunities

Source: Interviews; MGI analysis, How IT Enables Growth, McKinsey & Company, November 2002.

IT DID HAVE SIGNIFICANT IMPACT ON SOME PRODUCTIVITY LEVERS IN RETAIL BANKING

○ Low
◐ Medium
● High

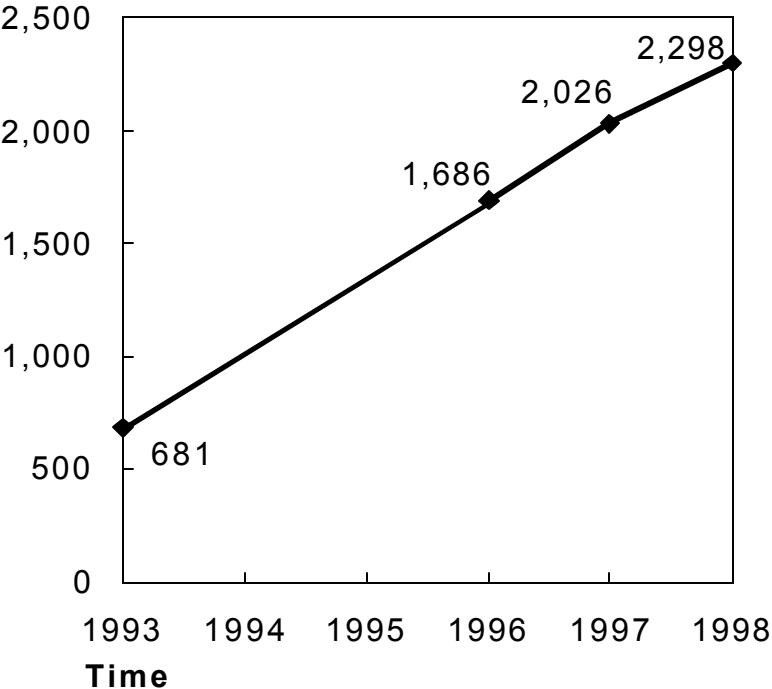
Productivity levers	Level of impact	IT applications associated with productivity lever*	Description
Substitute capital for labor	●	<ul style="list-style-type: none"> Lending systems Check imaging VRU (voice response unit)/ call center 	<ul style="list-style-type: none"> Lower call center costs from use of VRU/CTI in handling inquiries Check imaging lowered some labor/storage costs Increase in number and quality of loans processed due to credit scoring/ underwriting software
Deploy labor more effectively	◐	<ul style="list-style-type: none"> Lending systems Core banking systems 	<ul style="list-style-type: none"> Centralized credit authorization and review process by moving functions from branches to remote locations Some banks reduced maintenance costs through standardization of core systems
Reduce nonlabor costs	○	<ul style="list-style-type: none"> Check imaging 	<ul style="list-style-type: none"> High-volume image capture cut fixed costs but systems needed additional technicians
Increase labor efficiency	○	<ul style="list-style-type: none"> VRU/call center Branch automation CRM 	<ul style="list-style-type: none"> Disappointing results from attempting to enable tellers and call center agents to cross sell
Increase asset utilization	◐	<ul style="list-style-type: none"> VRU/call center 	<ul style="list-style-type: none"> VRU/IVR systems handled greater call volumes without additional customer service reps
Sell new value-added goods and services	◐	<ul style="list-style-type: none"> VRU/call center On-line banking Lending systems CRM Core banking systems 	<ul style="list-style-type: none"> Improved customer experience from new channels, but limited productivity impact New products from improved ability to design/price but higher costs from complexity
Shift to higher value-added goods in current portfolio	◐	<ul style="list-style-type: none"> CRM On-line banking Application integration 	<ul style="list-style-type: none"> Disappointing results from cross-selling efforts Low adoption of on-line banking Increased number of transactions from new products, but higher overall transaction costs
Realize more value from goods in current portfolio	○	<ul style="list-style-type: none"> n/a 	

* ATMs not included because majority of investments in ATM networks occurred before 1990

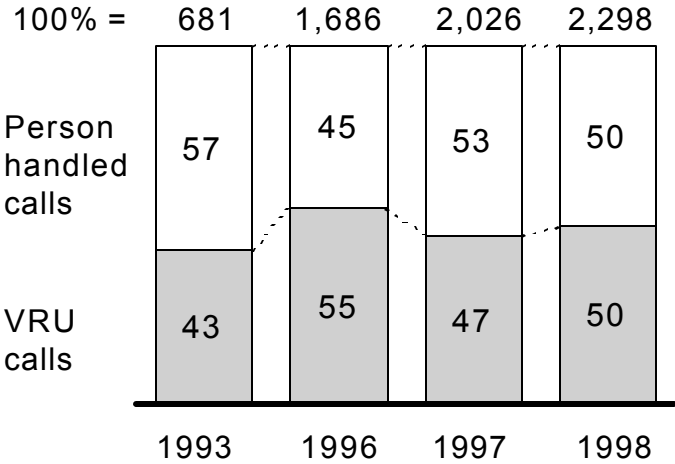
Source: Interviews; MGI analysis, How IT Enables Growth, McKinsey & Company, November 2002.

IT INVESTMENTS IN VRUs* HELPED BANKS CONTROL SPIRALING CUSTOMER SERVICE COSTS

Call volumes rise
Millions of call inquiries



Person vs. VRU calls
Percent; millions of call inquiries



Cost per VRU call Dollars	1993	1996	1997	1998
	0.32	0.23	0.27	0.18

* Voice Response Units

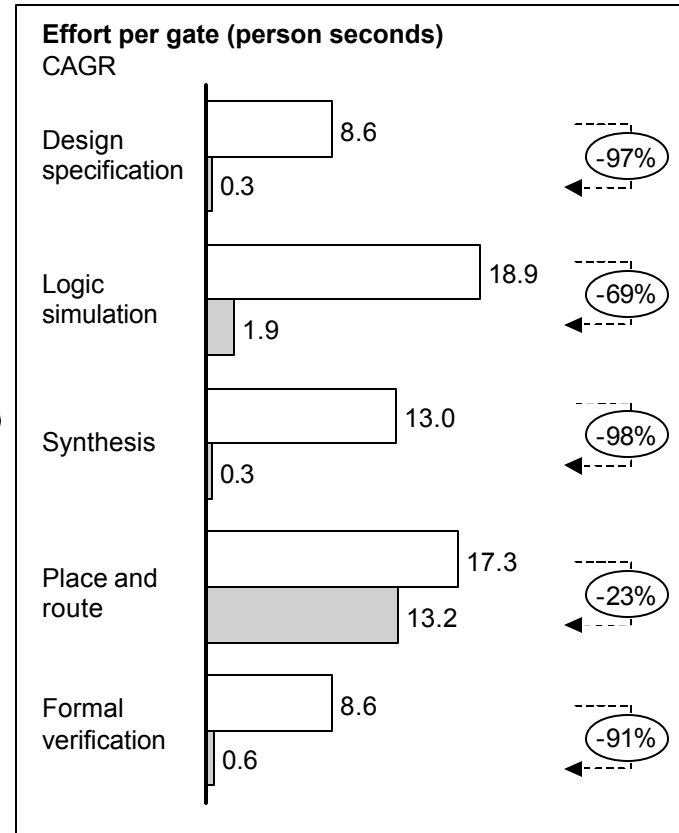
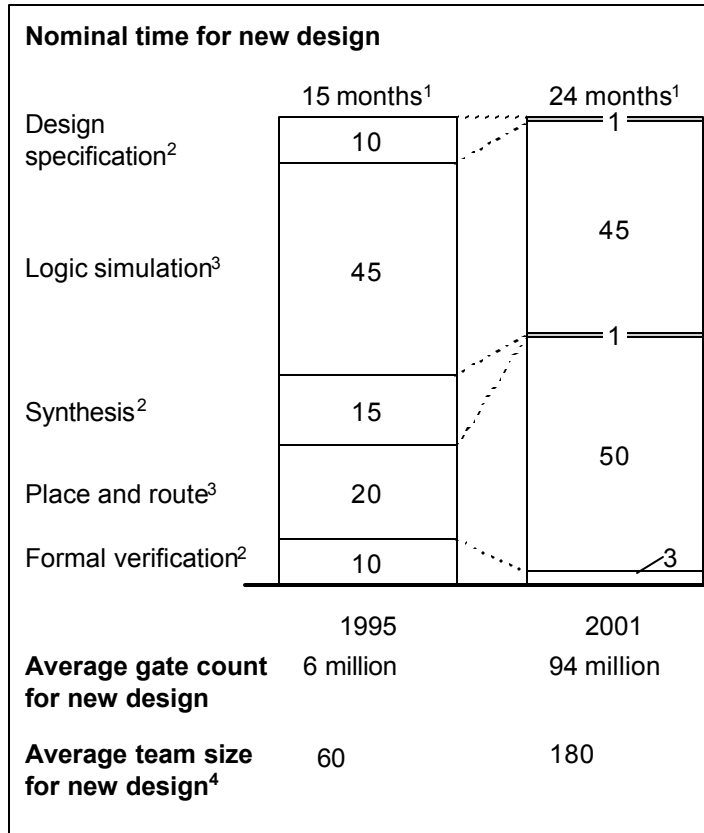
Source: ABA; MGI analysis, How IT Enables Growth, McKinsey & Company, November 2002.

- In 1998, VRUs handled nearly 4 times the call volume they had in 1993
- Cost per call handled by VRU decreased 44% from 1993 to 1998

NEW DESIGN TOOLS HELPED REDUCE “REAL” DESIGN TIME IN SEMICONDUCTORS

ASIC EXAMPLE

1995
2001

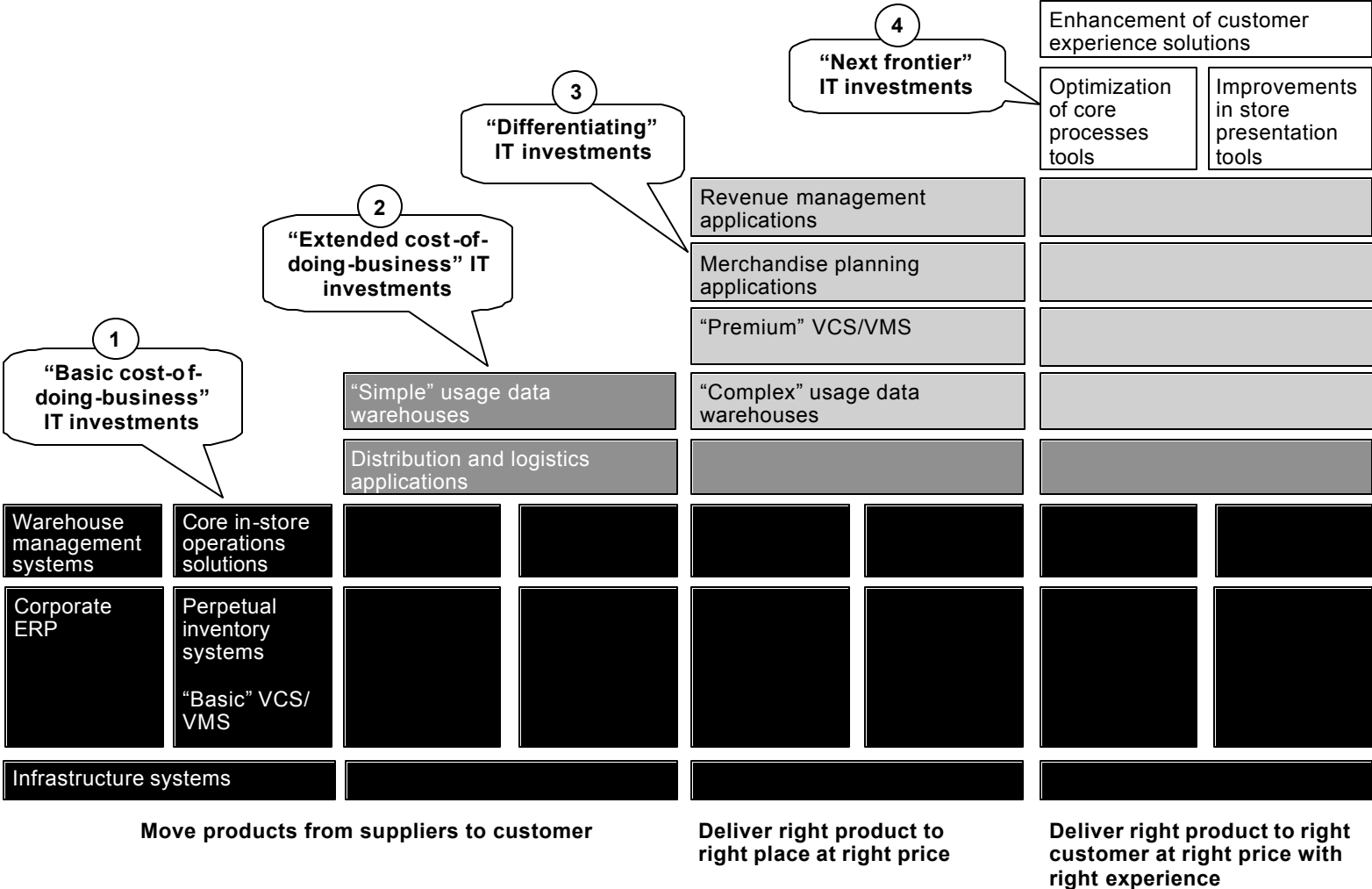


1 Average time for new design based on prevalent process technology (250 nm in 1995, 130 nm in 2001)
 2 Computing effort (e.g., computer time spent to calculate power consumption) scales roughly linearly with gate count
 3 Computing effort (e.g., computer time spent in checking for timing violations) scales nonlinearly with gate count
 4 Design team sizes have tripled in the past 10 years

Source: Interviews; McClean Report; MGI analysis, How IT Enables Growth, McKinsey & Company, November 2002.

IT INVESTMENTS IN RETAIL CAN BE SEGMENTED INTO FOUR TIERS

McKinsey Global Institute



Source: Interviews; MGI analysis, How IT Enables Growth, McKinsey & Company, November 2002.

SUCCESSFUL RETAILERS EVOLVED IT CAPABILITIES IN CONCERT WITH BUSINESS INNOVATION

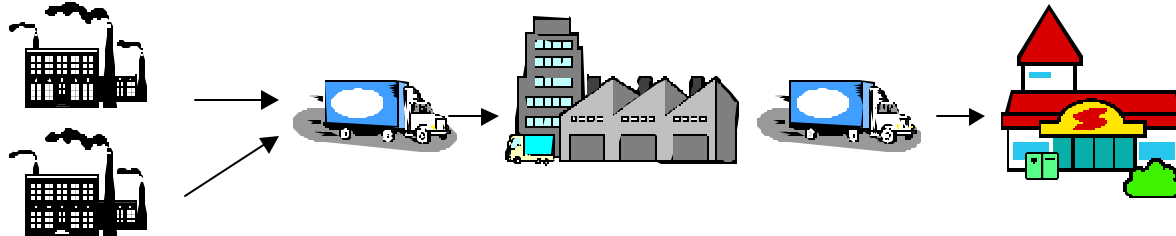
RETAIL EXAMPLE

Business innovation in

Supplier relationships

Distribution/logistics

Store diversification

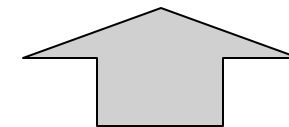
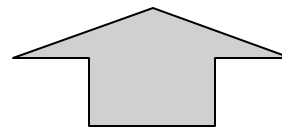
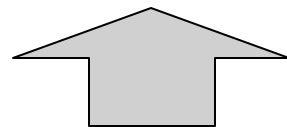


Business innovations

- Vendor collaboration
- Vendor and buyer accountability

- Reduction in inventory costs
- Frequent store replenishment

- New formats
- Store conversions
- Store experience



Supported by IT

- Communication links (e.g., EDI “Retail Link”)
- Vendor/buyer scorecards
- Company extranets
- Purchasing/sourcing exchanges

- Warehouse automation and management systems
- Cross-docking
- Inventory tracking

- In-store systems; POS and electronic scanning, “line busters”
- Micromerchandising applications

Source: Interviews, How IT Enables Growth, McKinsey & Company, November 2002.

Conclusions:

- Counting both the productivity growth within IT-producing industries and the productivity growth enabled by IT in using industries, IT did contribute to productivity growth in the 1990s and to the acceleration.
- The benefit of IT to consumers derives mostly from the using industries. Productivity did accelerate in these industries, but the evidence on the exact contributions of IT per se is mixed. Many IT investments failed.
- The standard tools of growth analysis do not capture adequately the ways in which IT innovation and business process innovation are related.
- The nature of IT-enabled innovations varies dramatically by industry.
- High competitive intensity drives innovation and productivity.