

# **New Drugs: Health and Economic Impacts**

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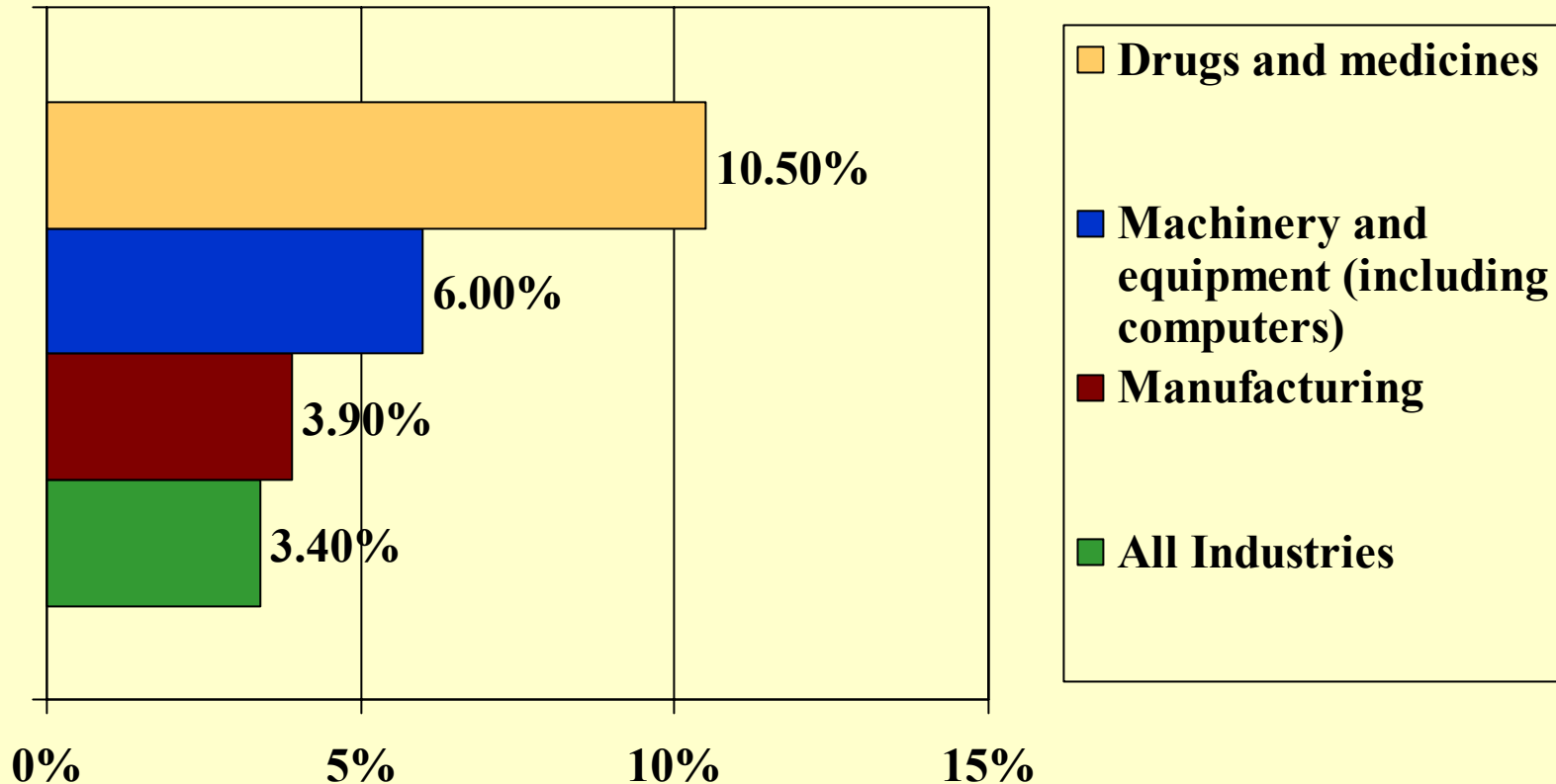
# Preview of Key Findings

- New drugs confer a number of important benefits:
  - Longer life
  - Reduced utilization of hospitals and other medical services
  - Higher productivity (greater ability to work)
  - Enhanced quality of life (fewer limitations on activities)
- *In the aggregate*, the benefits to society of new drugs exceed their costs by a substantial margin
- Policies that reduce the number and availability of new drugs deprive society of these benefits

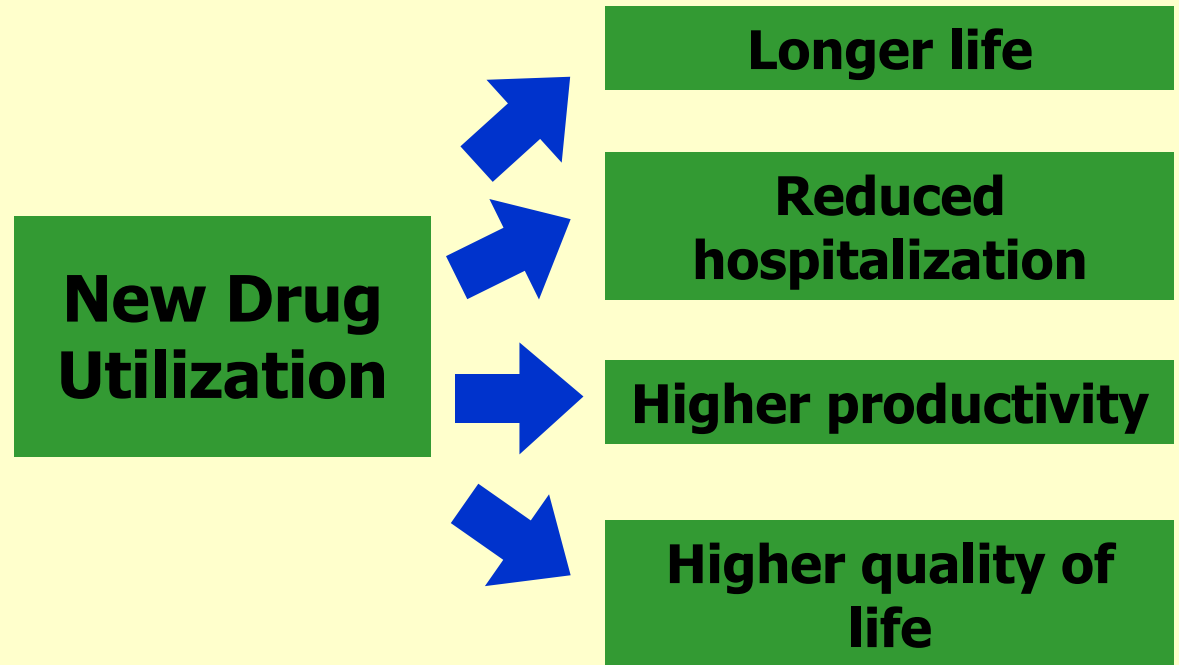
**Most economists agree that**  
*R&D is the fundamental  
source of economic growth*

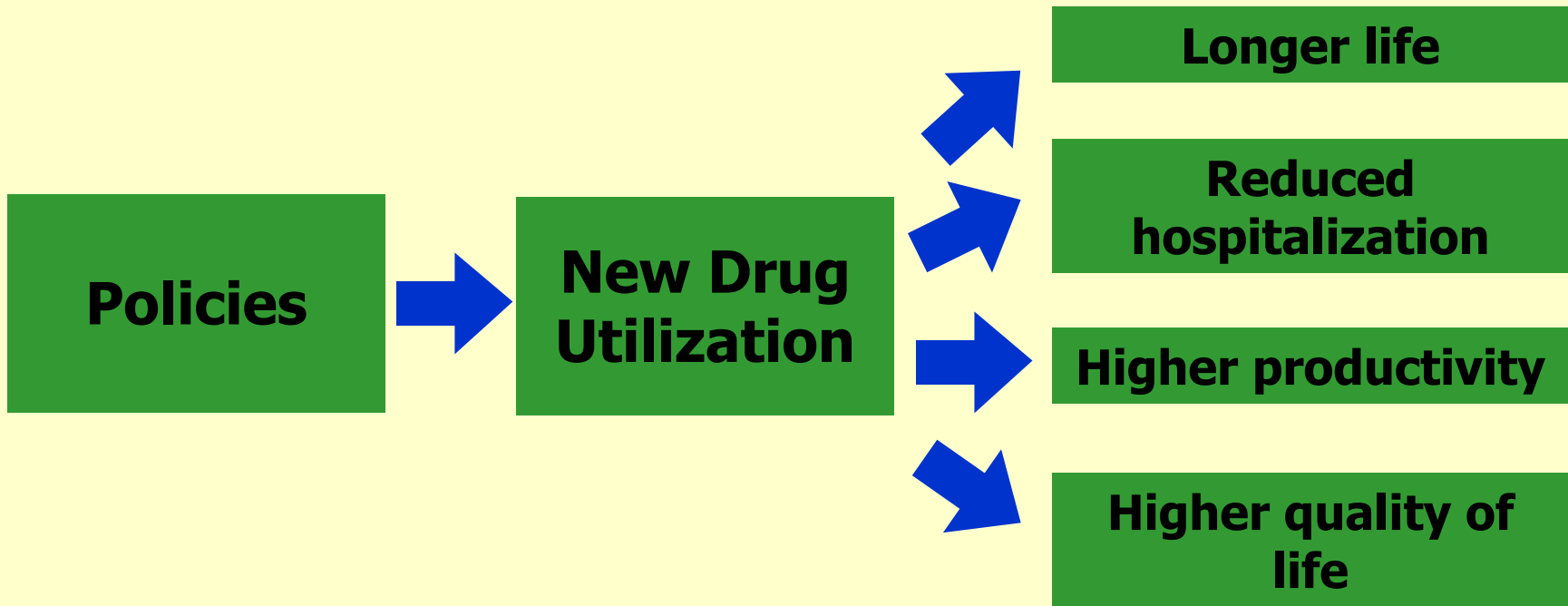


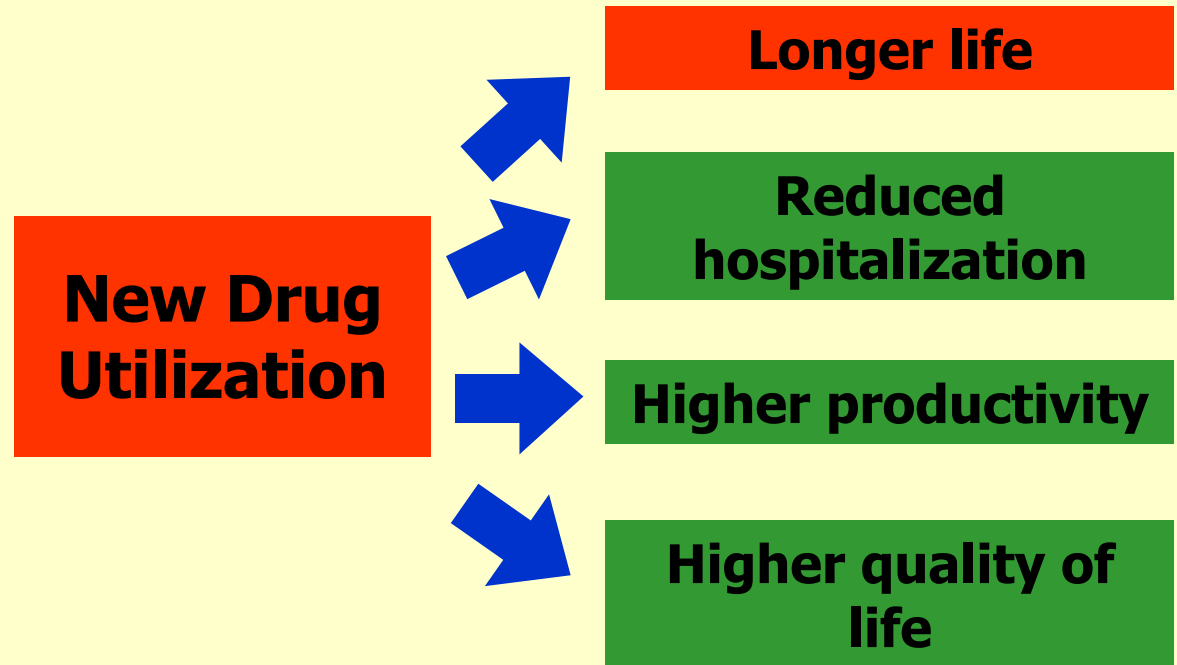
# The Pharmaceutical/Biotech Industry is the Most R&D-Intensive Sector of the Economy



Industrial R&D funds as a percent of net sales in  
R&D-performing companies, 1997

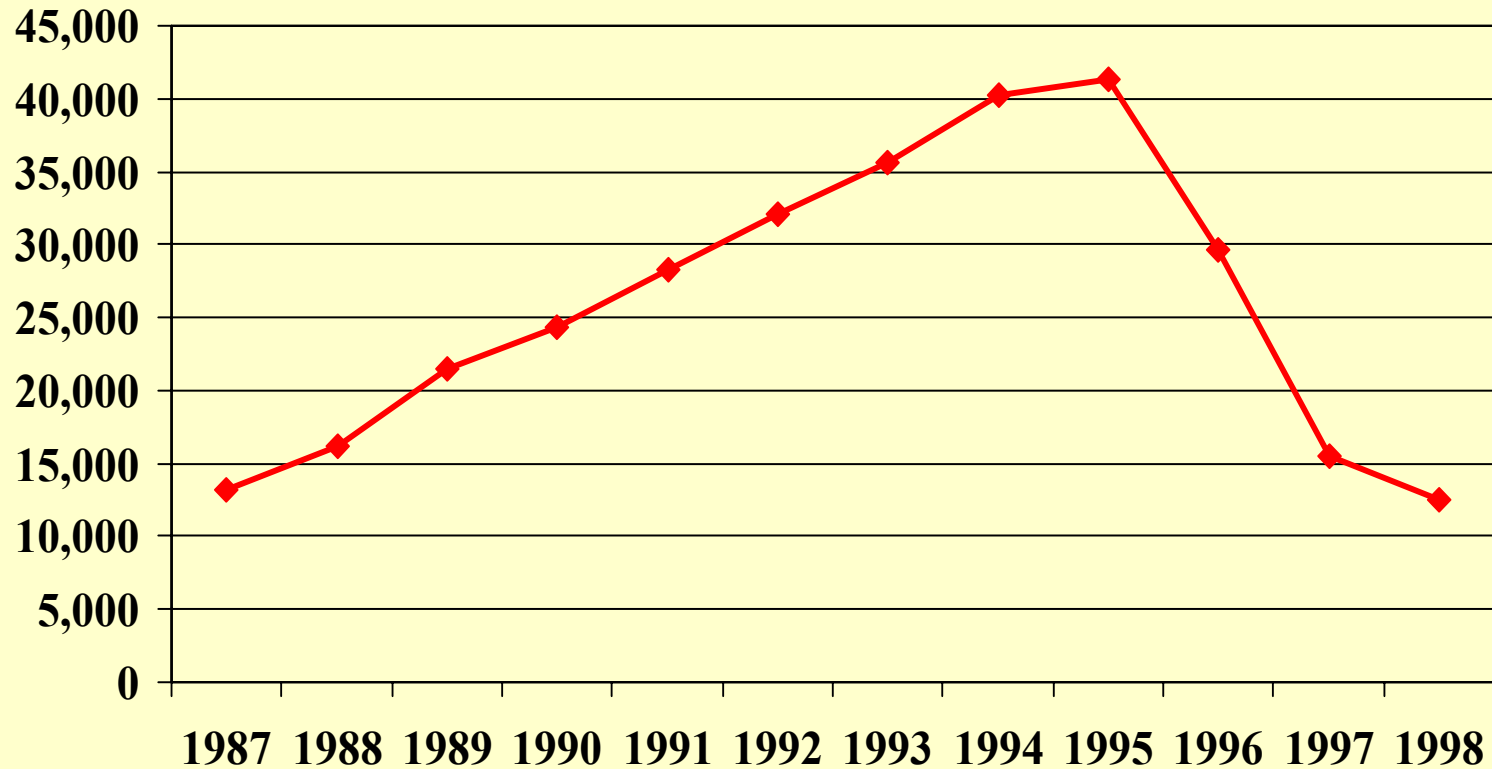






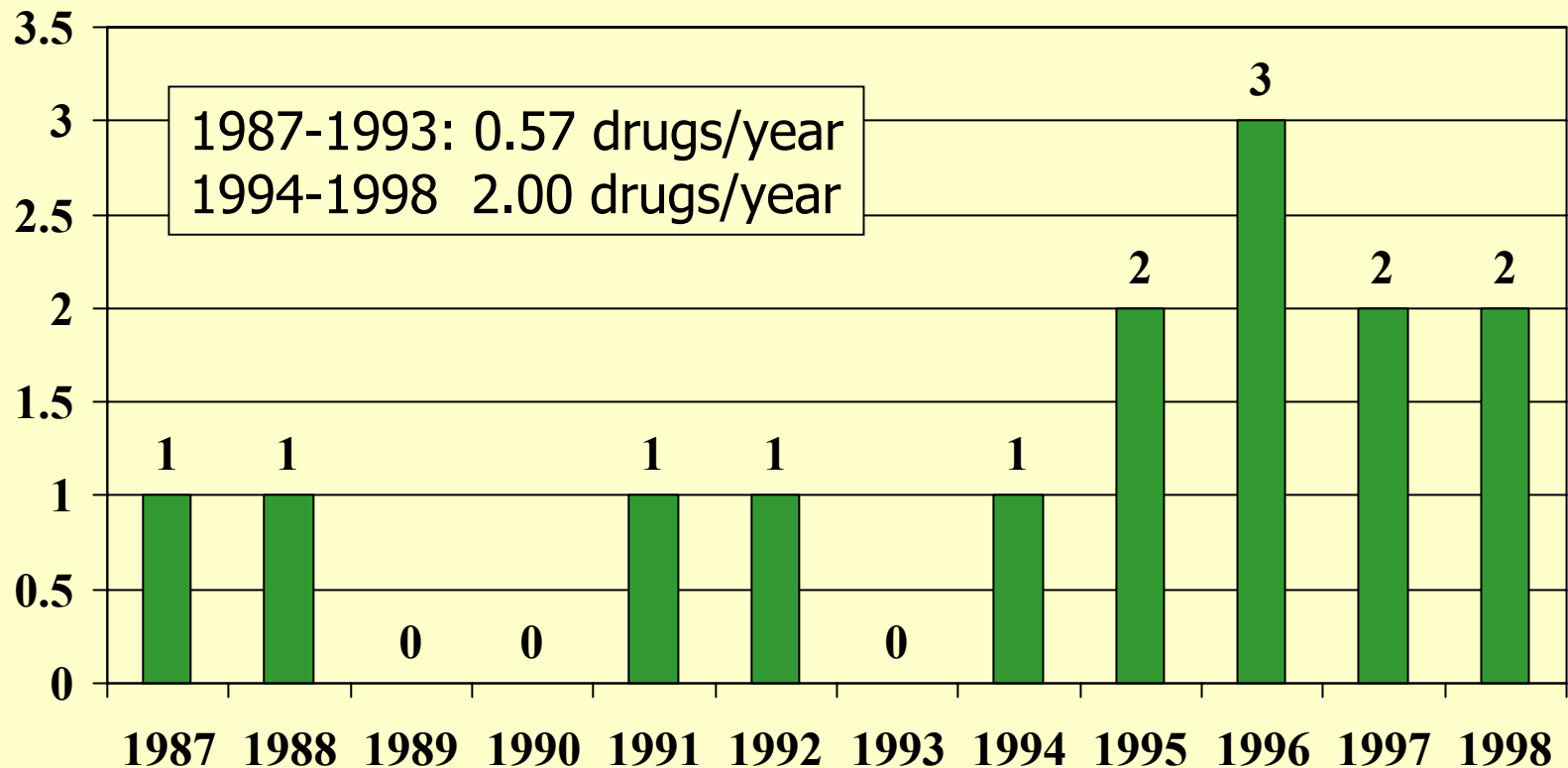
1. “Case study” of U.S. HIV mortality
2. Study of mortality from all diseases in 52 countries

# HIV mortality, U.S., 1987-1998

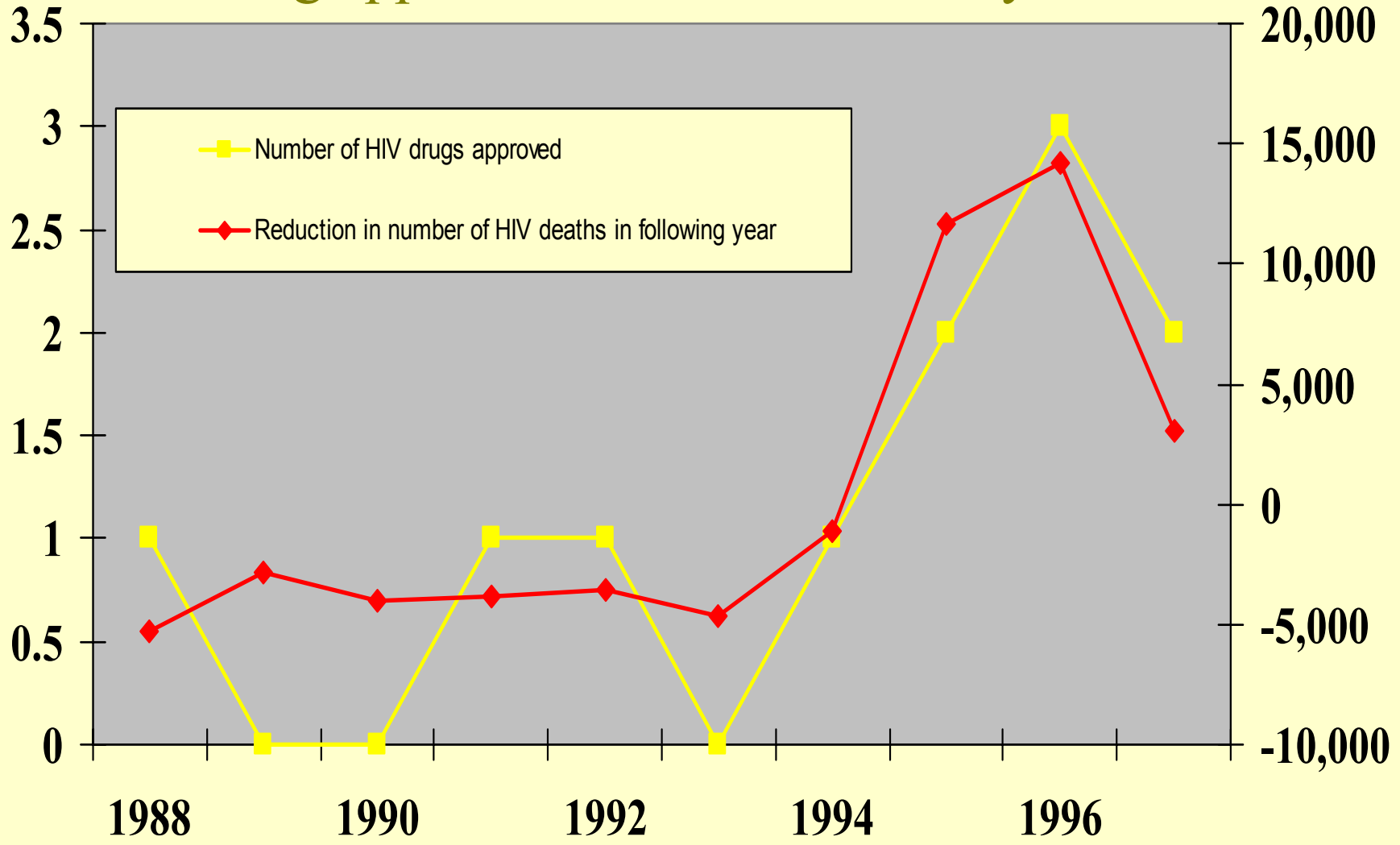


Source: CDC Compressed Mortality file

# No. of HIV drugs approved by the FDA



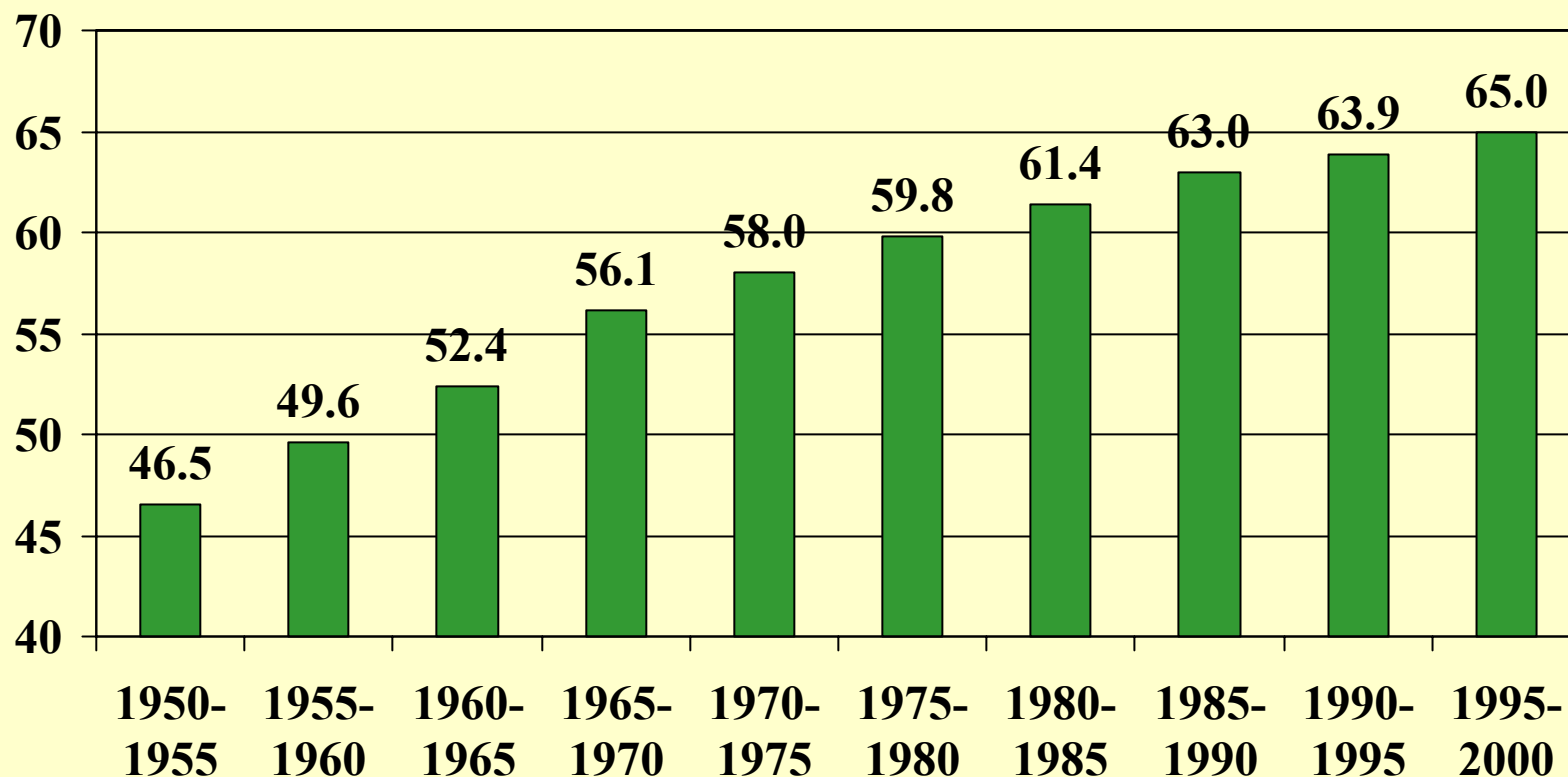
# HIV drug approvals and HIV mortality reduction



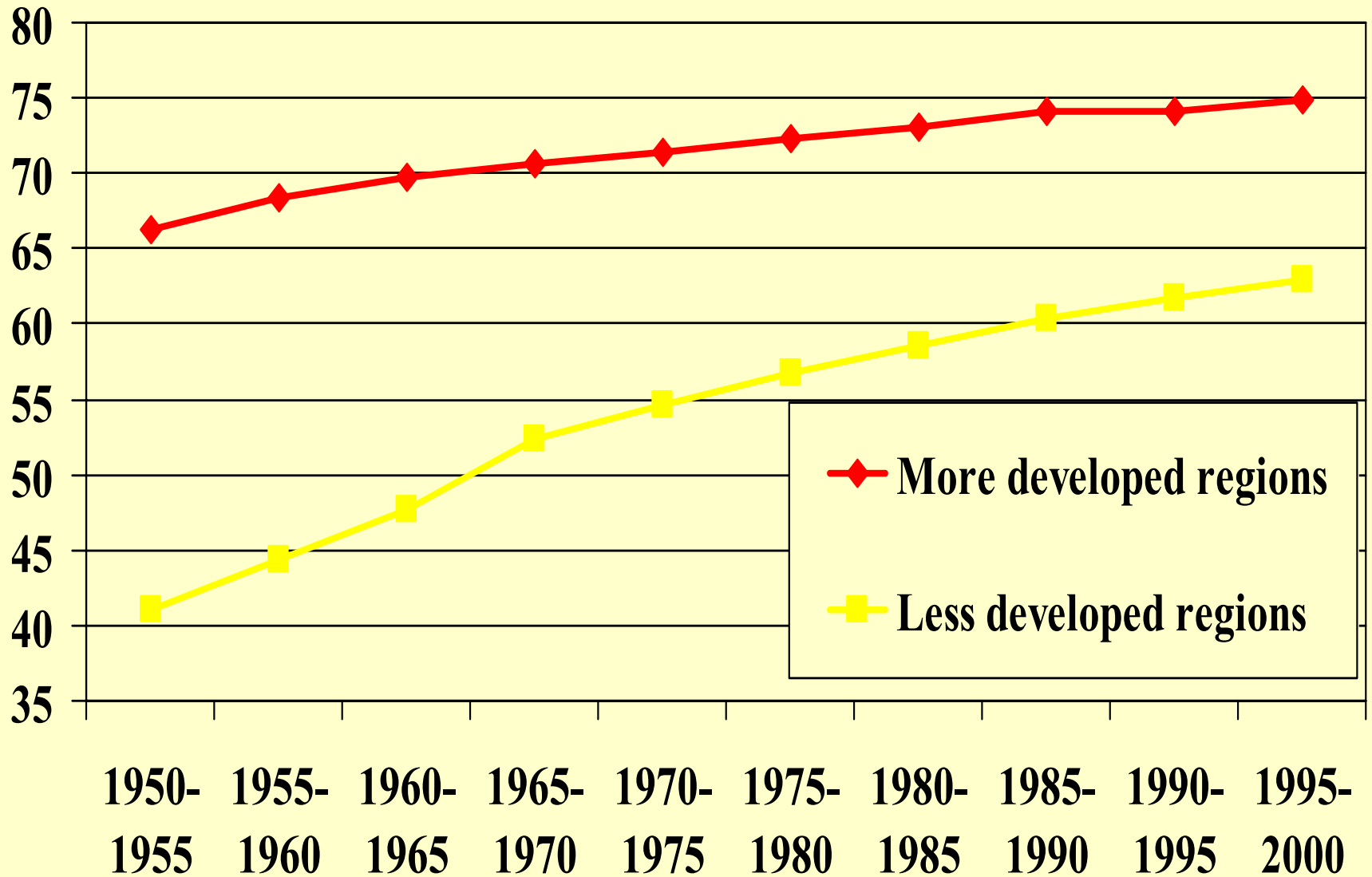
# Regression analysis

- $-\Delta \text{DEATHS}_t = -6328 + 6093 \text{FDA}_{t-1}$
- t-stats: (3.40) (4.74)
- Probability value associated with the  $\text{FDA}_{t-1}$  coefficient is .0015
- $R^2 = .7378$
- The annual number of U.S. HIV deaths has been reduced by 6100, on average, by one additional HIV drug approval
- Study is forthcoming in the journal *Economics and Human Biology*

# Life expectancy at birth, world, 1950-2000



# Life expectancy at birth, by region



# Health production function

$$\text{AGE\_DEATH}_{ijt} = \beta \ln(\text{N\_DRUG}_{ij,t-k}) + \gamma X_{ijt} + \varepsilon_{ijt}$$

$\text{AGE\_DEATH}_{ijt}$  = a statistic based on the age distribution of deaths from disease  $i$  in country  $j$  in year  $t$

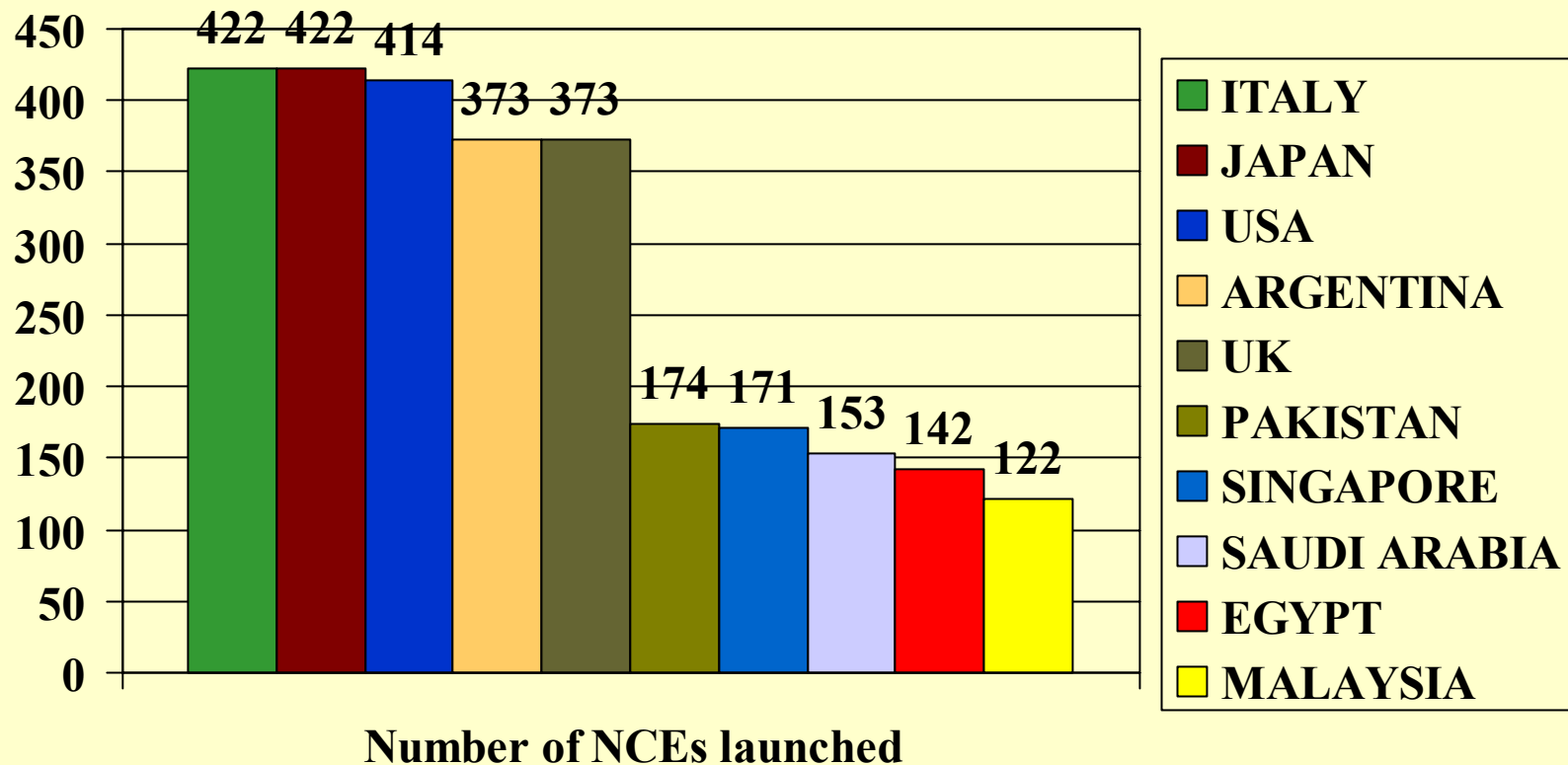
$\text{N\_DRUG}_{ij,t-k}$  = the number of drugs launched to treat disease  $i$  in country  $j$  by year  $t-k$

$X_{ijt}$  = a vector of other factors (e.g. education, income, nutrition, the environment, and “lifestyle”) affecting the age distribution of deaths from disease  $i$  in country  $j$  in year  $t$

# IMS Health Drug Launches database

- Has tracked new product introductions worldwide since 1982
- In August 2001 the database contained over 165,000 records of individual product introductions between 1982 and 2001
- Allows measurement, for each country and therapeutic area, of the total number of ingredients launched, and the number of new chemical entities launched

# Countries with most and fewest drug launches



# WHO Mortality database

- Provides data on the age distribution of deaths, by disease, country, and year
- Use aggregate life tables to translate our estimates of the impact of new drug launches on survival probabilities into estimates of the impact of new drug launches on life expectancy

## 11 broad disease categories

IMS drug class(es)	ICD10 codes	ICD10 disease class(es)
A Alimentary Tract And Metabolism	K00-K92, E00-E88	Diseases of the digestive system; endocrine, nutritional and metabolic diseases
B Blood and Blood Forming Organs	D50-D89	Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism
C Cardiovascular System	I00-I99	Diseases of the circulatory system
D Dermatologicals	L00-L98	Diseases of the skin and subcutaneous tissue
G Genitourinary System and Sex Hormones	N00-N98	Diseases of the genitourinary system
J General Anti-Infectives, Systemic; P Parasitology	A00-B99	Certain infectious and parasitic diseases
L Cytostatics	C00-D48	Neoplasms
M Musculoskeletal System	M00-M99	Diseases of the musculoskeletal system and connective tissue
N Central Nervous System (CNS)	F01-F99, G00-G98	Mental and behavioural disorders, diseases of the nervous system
R Respiratory System	J00-J98	Diseases of the respiratory system
S Sensory Organs	H00-H5, H60-H93	Diseases of the eye and adnexa; diseases of the ear and mastoid process

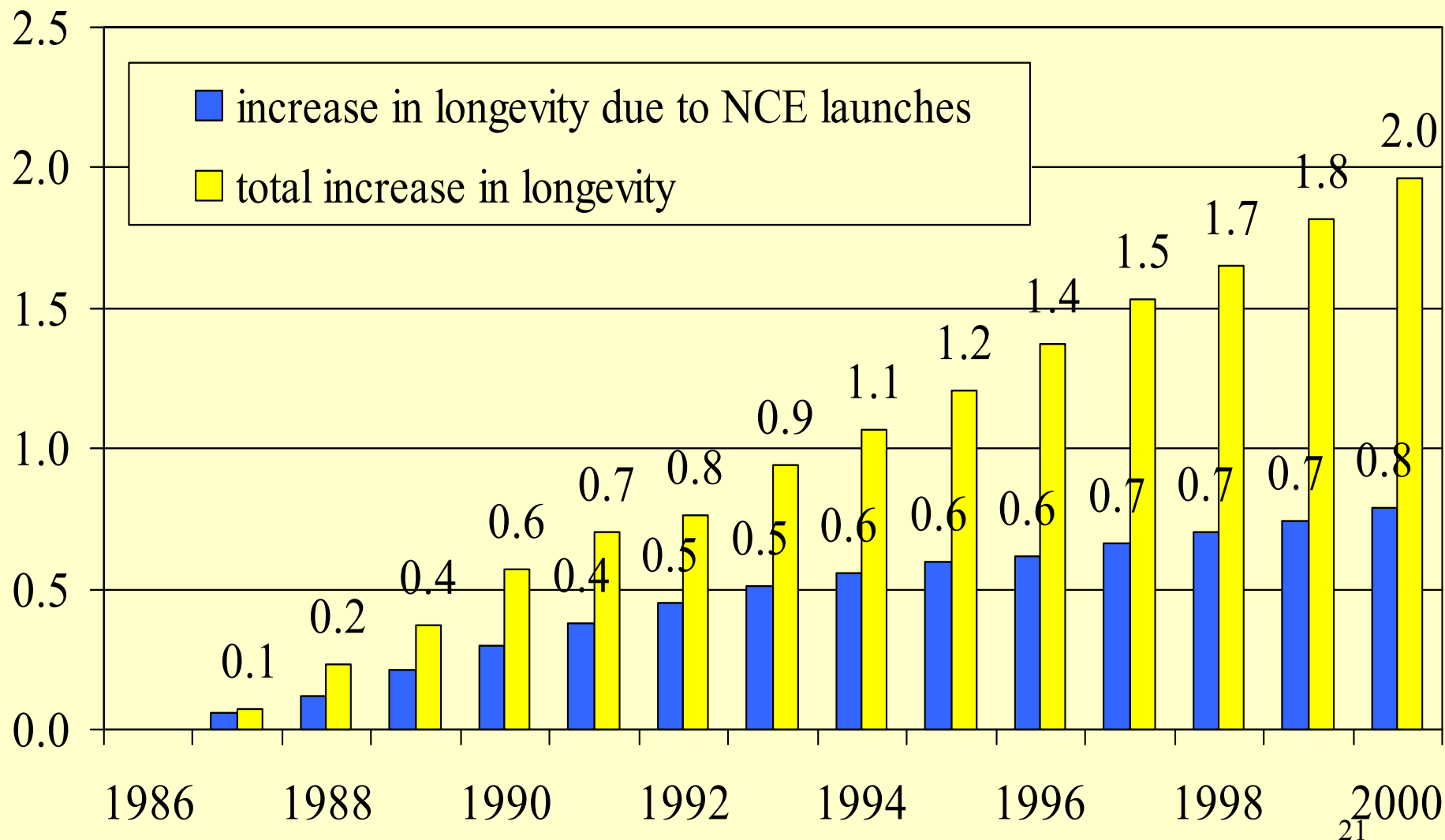
# Findings

- Launches of New Chemical Entities (NCEs) have a strong positive impact on the probability of survival
- It takes at least three years for new NCE launches to have their maximum impact on survival rates
- This is probably due to the gradual diffusion of drugs to consumers following launch; data on pharmaceutical expenditure are consistent with this interpretation
- Launches of (older) drugs that are not NCEs—many of which may already have been on the market—do not increase longevity

# Contribution of NCE launches to longevity increase

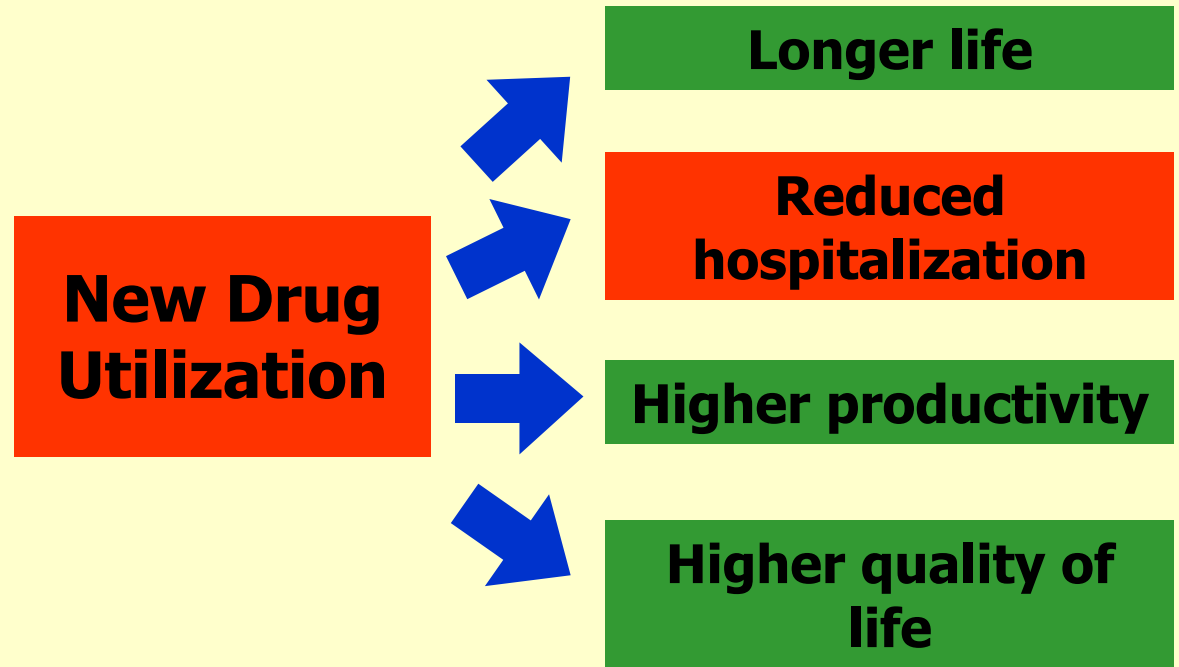
- NCE launches appear to account for a significant fraction of the long-run increase in longevity in the sample as a whole
- Between 1986 and 2000, average life expectancy of the entire population of sample countries increased by almost two (1.96) years.
- The estimates imply that NCE launches accounted for 0.79 years (40%) of the 1986-2000 increase in longevity.
- The average annual increase in life expectancy of the entire population resulting from NCE launches is .056 years, or 2.93 weeks.

# Contribution of NCE launches to increase in average life expectancy of the population since 1986



# Cost per life-year gained from the launch of NCEs

- In 1997, average per capita pharmaceutical expenditure in OECD countries was about \$250
- The average annual increase in life expectancy of the entire population resulting from NCE launches is .056 years
- Hence *pharmaceutical expenditure per person per year divided by the increase in life-years per person per year attributable to NCE launches is about \$4500*
- *This is far lower than most estimates of the value of a life-year*
- Moreover, since the numerator includes expenditure on old drugs as well as on recently-launched NCEs, it probably grossly overstates the cost per life-year gained from the launch of NCEs



# Key Hypothesis

All other things being equal, a person's health is an increasing function of the vintage\* of the drugs he or she consumes

\* Vintage: the year in which the FDA first approved a drug

# Benefits and Costs of Newer Drugs

- Compares total medical expenditures of people using new drugs to that of people using old drugs
- Controls for: age, sex, race, education, income, diagnosis, insurance status, disease duration, number of co-morbidities
- Published in *Health Affairs*, Sept./Oct. 2001

# Comparison Example

- Two 70-year-old, white, high-school graduates, with income of \$40K, covered by Medicare and private insurance, both taking anti-arrhythmic medication, for a condition they have had for 12 years
- One man is taking a drug approved by the FDA in 1950; the other is taking a drug approved in 1995

# Controlling for other factors

I control for *all* individual characteristics—both observed (e.g. age of the patient) and unobserved (e.g. age and practice style of his physician)—that determine medical expenditure and that may be correlated with the age of the drug.

# Findings

- Newer drugs associated with lower total medical costs and fewer lost work days
- *Net cost savings:* Reduction in medical expenditures from using a newer drug almost 4x greater than added cost of that drug

# Benefits and Costs of Newer Drugs: An Example

- Replace prescription for 15 year-old drug with one for 5 year-old drug; cost increase is \$18 (on average)
- This switch to newer drug reduces use and costs of medical services, including hospital stays, office visits, home health care, and outpatient visits

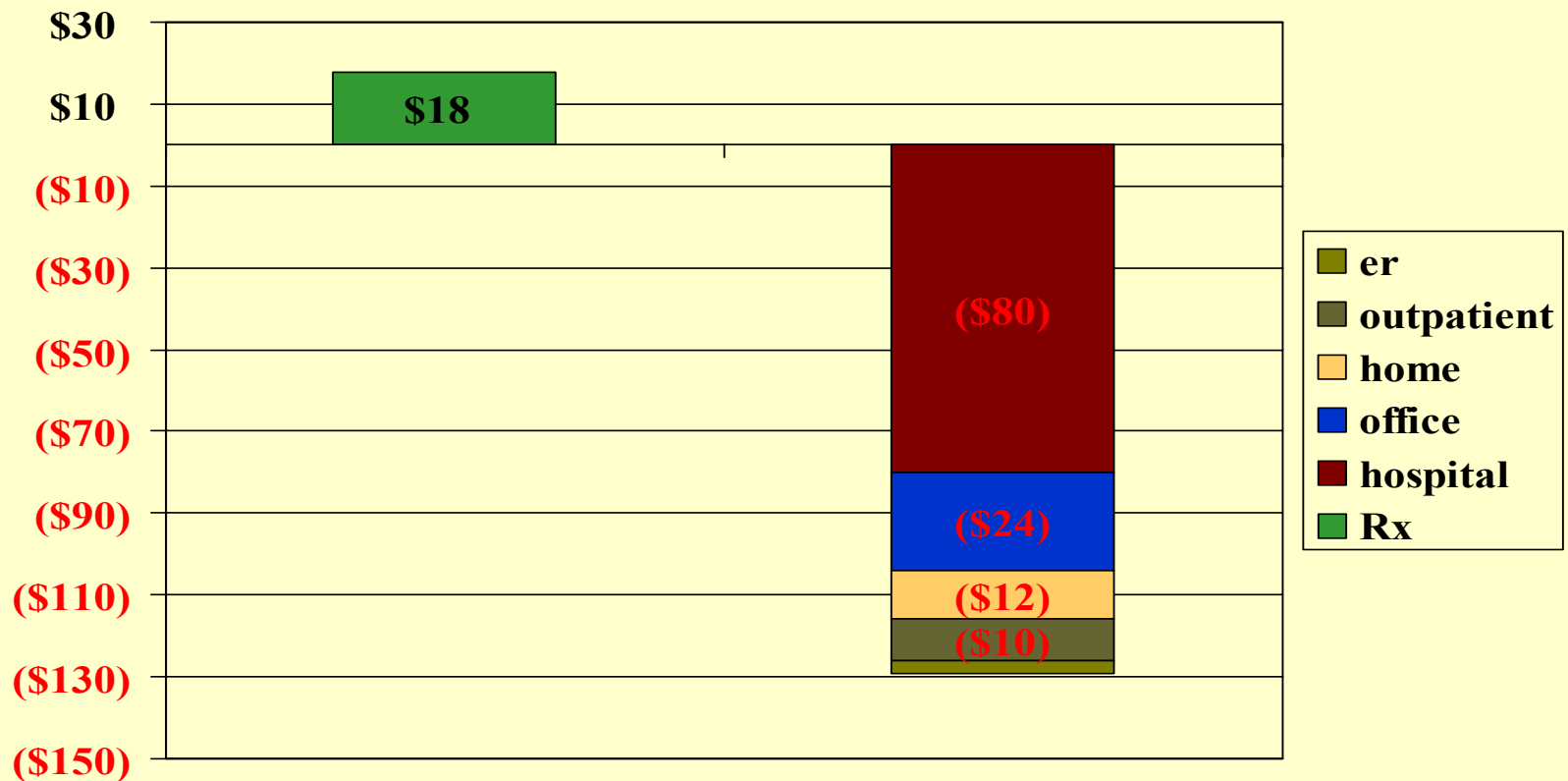
# Benefits and Costs of Newer Drugs: An Example

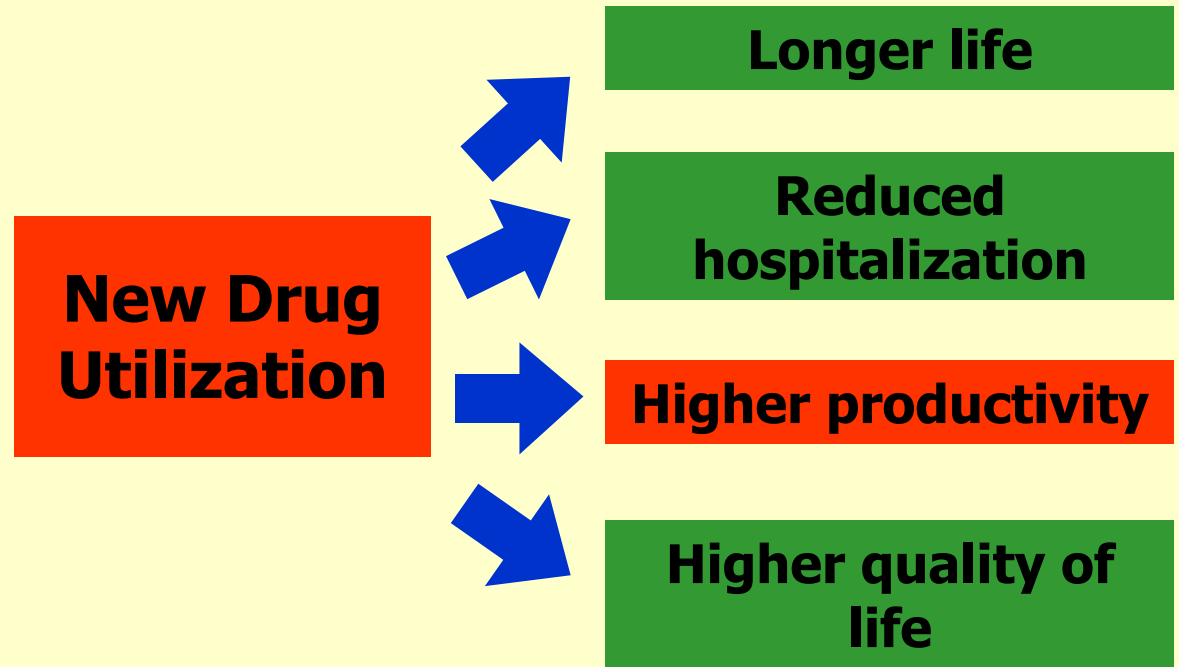
- Estimated reduction in non-drug medical costs is \$71; net savings from replacing old with new drug is \$53 ( $\$71 - \$18$ )
- Switching from old drug to new drug reduces expected hospital admissions by 6 per 1,000 people; overall saving =  $\$47,148 / 1,000$  people

# Update of original study

- Since I performed the original study, MEPS data for 1997 and 1998 have become available, enabling a substantial increase in sample size.
- New estimates indicate that use of newer drug (which costs \$18 more) reduces other medical costs by \$129, on average
- Reduction in medical costs incurred by just one payer—Medicare—exceeds increase in drug costs.

# Impact of using newer drug on Rx cost and other medical costs





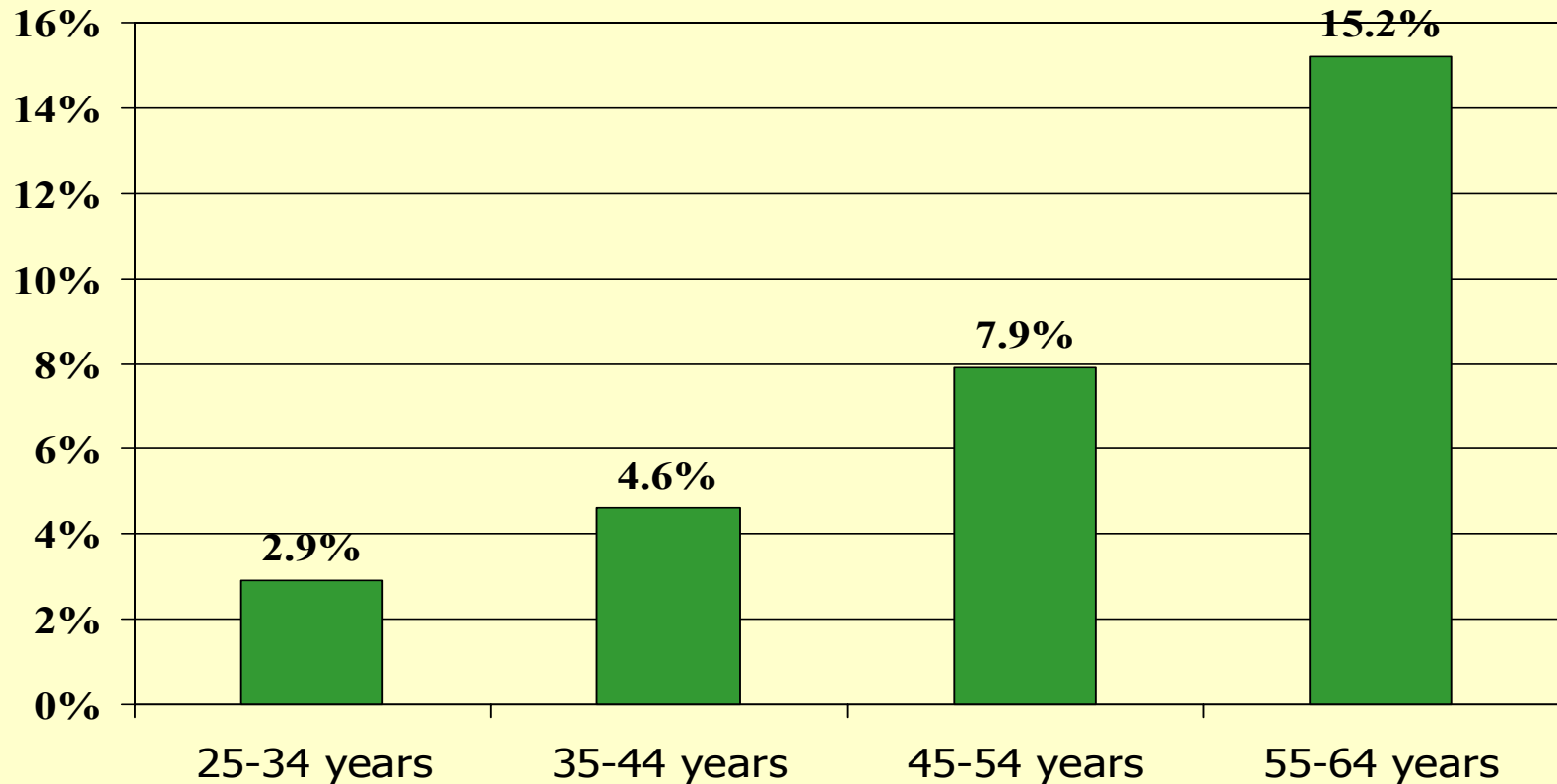
# Key points

- Illness and disability impose substantial costs on society in general, and employers in particular
- New drugs and other medical innovations reduce the economic burden of illness and disability
- The evidence indicates that the benefits to employers of new drugs, in the form of reduced work-loss time, exceed the incremental cost of new drugs

# Illness and disability reduce total hours worked in two ways

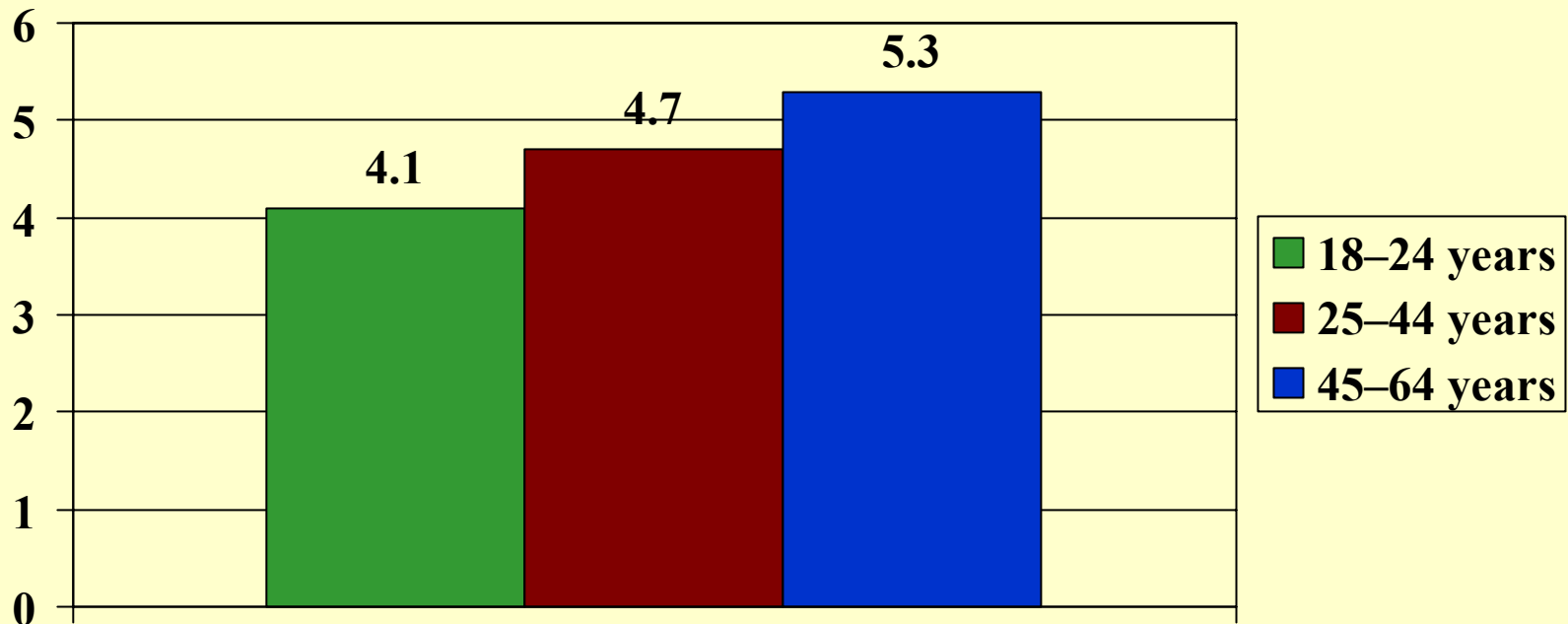
- Reduce *size* of labor force
- Reduce *hours worked per member* of labor force

# % of People Unable to Work, by Age



Illness-induced early retirement of older workers: *human-capital losses*

# Number of work-loss days per currently employed person per year in 1996



Number of work-loss days per currently employed person per year in 1996

# Illness and disability reduce total hours worked in two ways

- *Size* of labor force is reduced by 6.6%: in 1996, 8.7 million Americans age 18-64 were completely unable to work due to illness or disability
- *Hours worked per member* of labor force is reduced by about 2%
- Total effect: total hours worked is reduced by about 8.6%

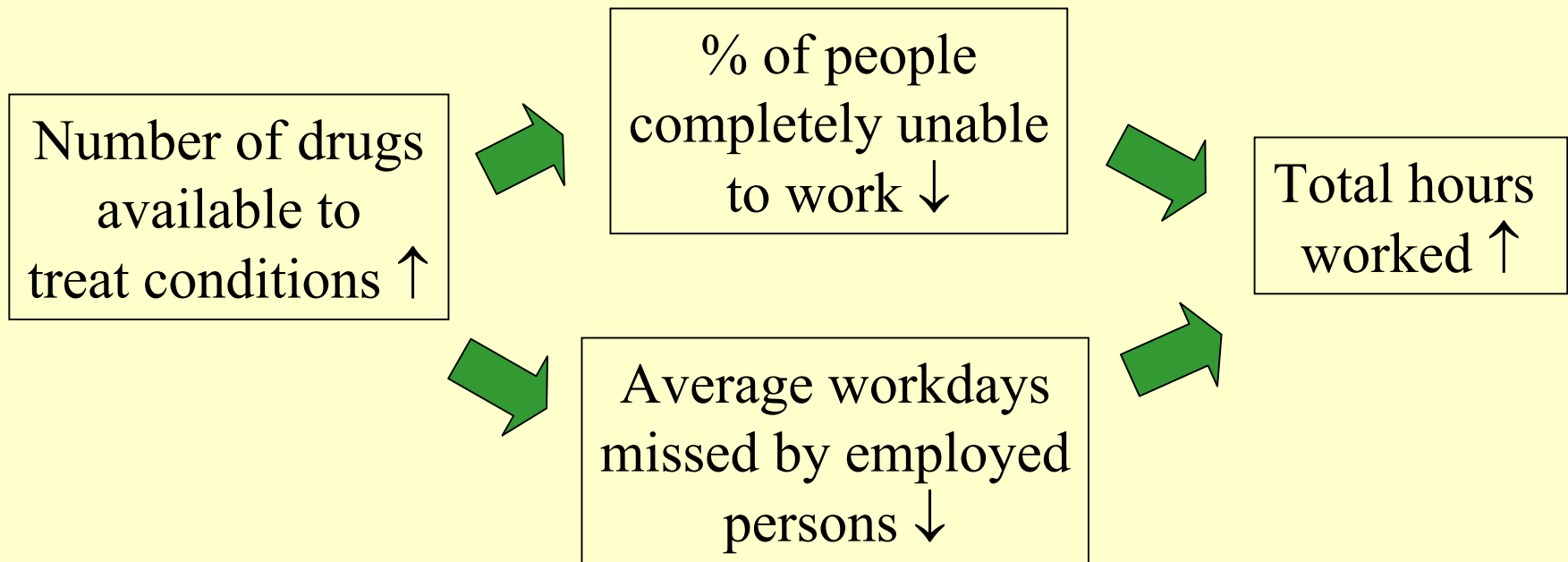
*Source: Author's calculations based on Current Estimates From the National Health Interview Survey, 1996. National Center for Health Statistics Vital Health Stat 10 (200), 1999.*

# Magnitude of the cost

- Illness and disability reduce total hours worked by about 8.6% →
- Illness and disability reduce total number of hours worked by about 20 billion/year →
- The value of the reduction in hours worked due to illness and disability is about \$468 billion/year (much larger than this year's federal budget deficit)

# Hypothesis:

the introduction and use of new drugs  
reduces the number of work hours lost  
due to illness and disability

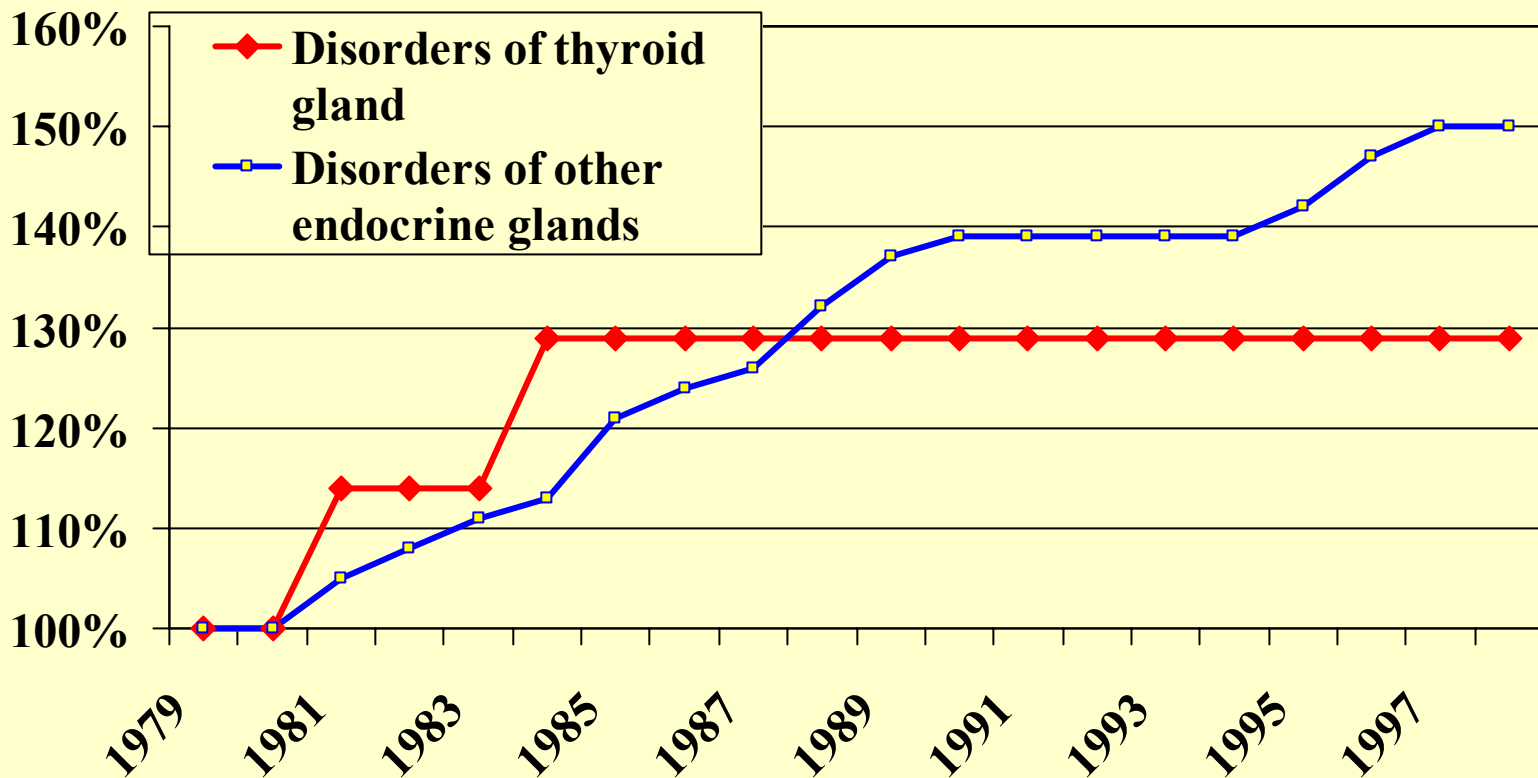


# Example: FDA Approves Biotechnology Drug for Psoriasis

1 February 2003: “The Food and Drug Administration has approved Amevive, the first drug from the biotechnology industry to treat psoriasis, opening what doctors say will be a new era in treating the disease, a sometimes debilitating skin ailment.”

“Doctors said Amevive, as well as several other biotechnology drugs that are expected to be approved in the next two years, could help patients with severe psoriasis without the side effects of existing drugs, which can cause liver or kidney damage.”

# Rate of introduction of new drugs varies across diseases



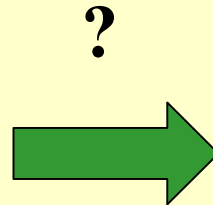
Number of drugs available to treat condition in year  $t$ ,  
as % of number of drugs available to treat condition in 1979

# Methodology

- Rate of introduction of new drugs varies across diseases
- Examine relationship across diseases between change in pharmaceutical treatment of the disease and change in inability to work due to that disease
- Three alternative indicators of change in pharmaceutical treatment:
  - Increase in number of drugs approved to treat disease
  - Change in average number of prescriptions per condition per year
  - Change in average age (years since FDA approval) of prescriptions used to treat disease

# Approach #1

Change in average  
number of  
prescriptions filled  
to treat a condition  
in a year



Change in % of  
people who had one  
or more missed  
workdays associated  
with the condition

Data: 1996-1998 Medical Expenditure Panel Surveys

Control for change in number of office visits and hospital admissions

# Finding

Conditions for which there were above-average increases in utilization of prescriptions tended to have above-average reductions in the fraction of people who had one or more missed workdays associated with the condition.

# Increase of one Rx per condition per year: cost vs. benefit

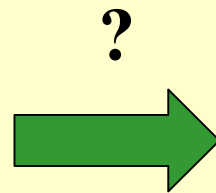
- To a first approximation, the increase in drug cost would simply be the average cost of a prescription, which was \$34.76 in 1996.
- One additional Rx would reduce the *probability* of missing any work days by 5.1%.
- It would reduce the *expected number* of missed work days by 0.31 days, or 2.18 work hours.
- In 1996, employer costs for employee compensation per hour worked was \$18.68, so the value of this reduction was \$40.64.

# Net benefit of Rx increase to employers is positive

- Estimated value to employers of the reduction in missed work days was \$40.64 in 1996.
- This exceeds average Rx cost (\$34.76).
- Moreover, about 15% of Rx cost is borne by employees (copayments), so average employer Rx cost was \$29.66.

# Approach #2

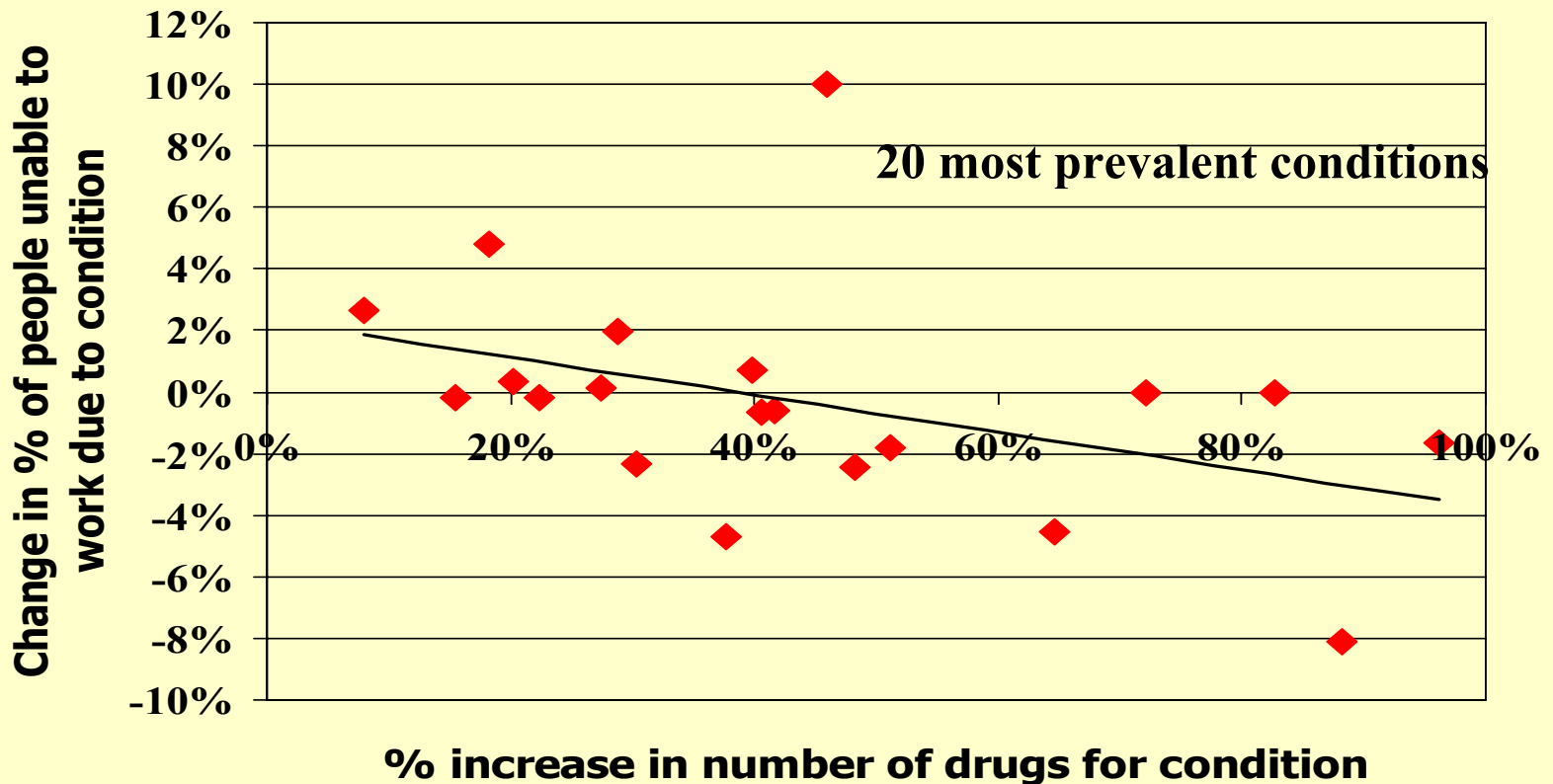
Increase in number  
of drugs approved  
to treat condition



Change in fraction  
of people with  
condition who  
were unable to  
work

Data: 1983-1996 National Health Interview Surveys; FDA data.

# Increase in number of drugs available → decrease in inability to work



1983-1996 increase in number of drugs reduced all of the following by about 12% in 1996

- Number of people unable to work
- Work-loss days of currently employed persons
- Restricted-activity days of all persons
- Bed days of all persons

# Estimated effects of 1983-96 new drug approvals

- reduction in number of people unable to work: 1.44 million
- value of reduction in number of people unable to work (@ \$30K/year): \$43.3 billion/year
- reduction in work loss days per year of currently employed persons: 98.8 million/year
- value of reduction in work loss days (@ \$100/day): \$9.9 billion/year
- reduction in restricted activity days of all persons: 423 million/year
- reduction in bed days of all persons: 178 million/year

# Preview of Key Findings

- New drugs confer a number of important benefits:
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  - Reduced utilization of hospitals and other medical services
  - Higher productivity (greater ability to work)
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