

# Pharmaceutical innovation and cancer survival

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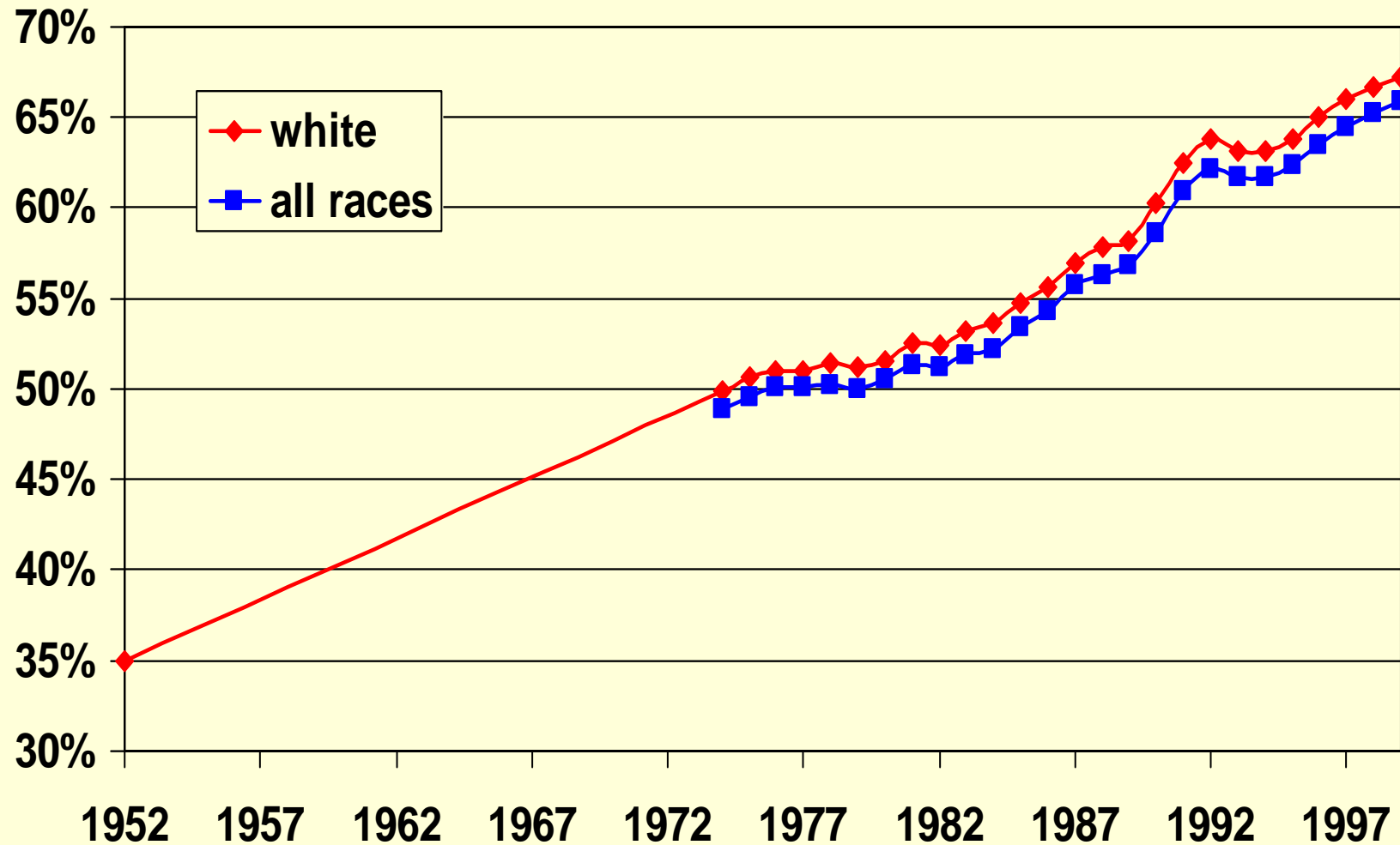
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# Preview

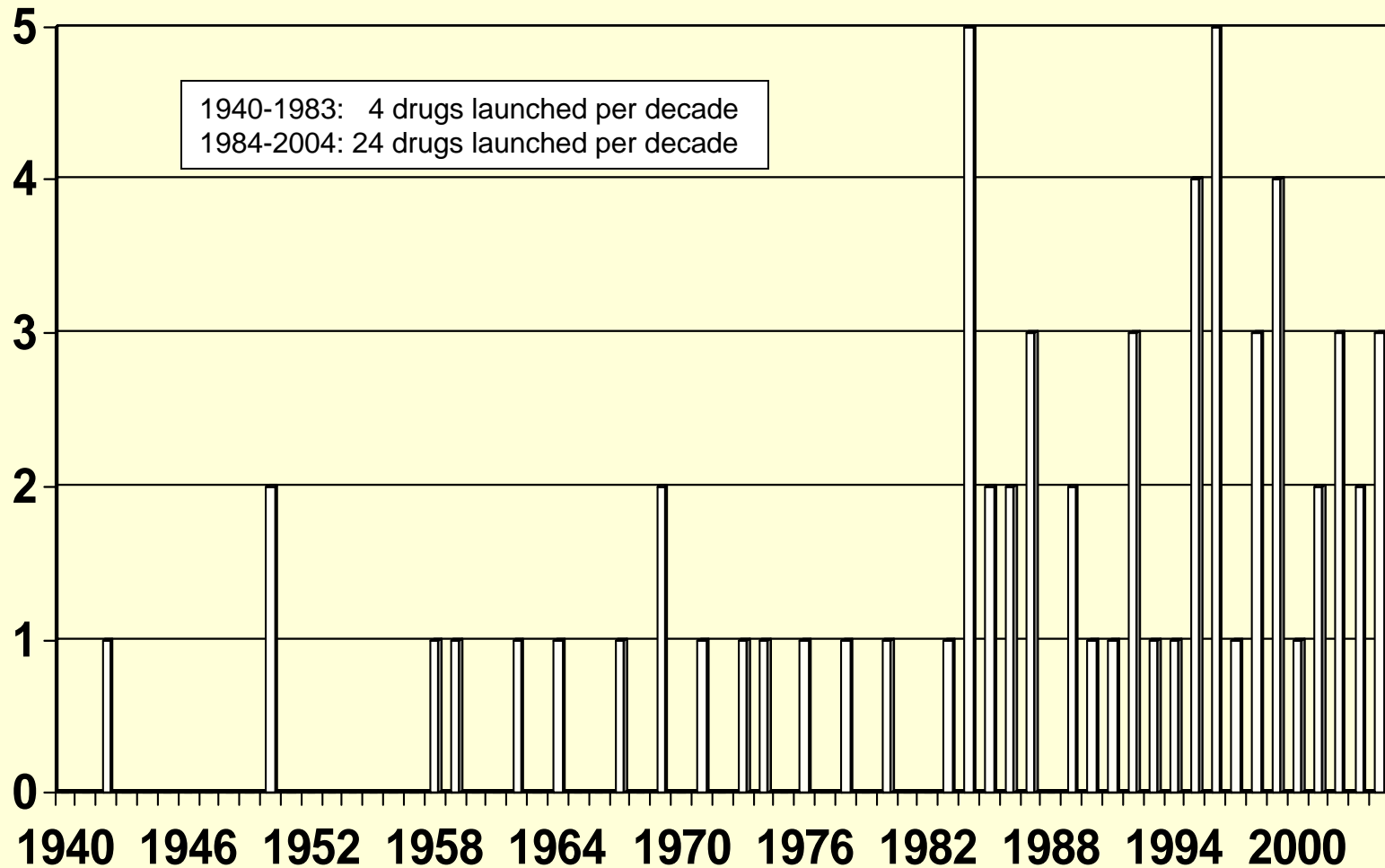
- Cancer survival rates have increased substantially in the last 50 years
- Many new cancer drugs have been introduced during that time
- I hypothesized that the development and use of new cancer drugs has made an important contribution to the increase in cancer survival
- I tested this hypothesis by analyzing the relationship between drug vintage (FDA approval year) and cancer survival in 3 different ways, using 3 different kinds of data:
  - Data on cancer cases by primary cancer site and year, for a given country (the U.S.)
  - Data on cancer cases by primary cancer site and country, for a given year (2002)
  - Data on cancer cases by country and year, for all cancer sites combined
- All three analyses provided support for the hypothesis that, in general, use of new cancer drugs has increased cancer survival rates

## 5-year relative survival rate, all cancer sites



Sources: [http://seer.cancer.gov/csr/1973\\_1993/overview.pdf](http://seer.cancer.gov/csr/1973_1993/overview.pdf);  
<http://seer.cancer.gov/seerstat/>

# Number of cancer drugs first launched



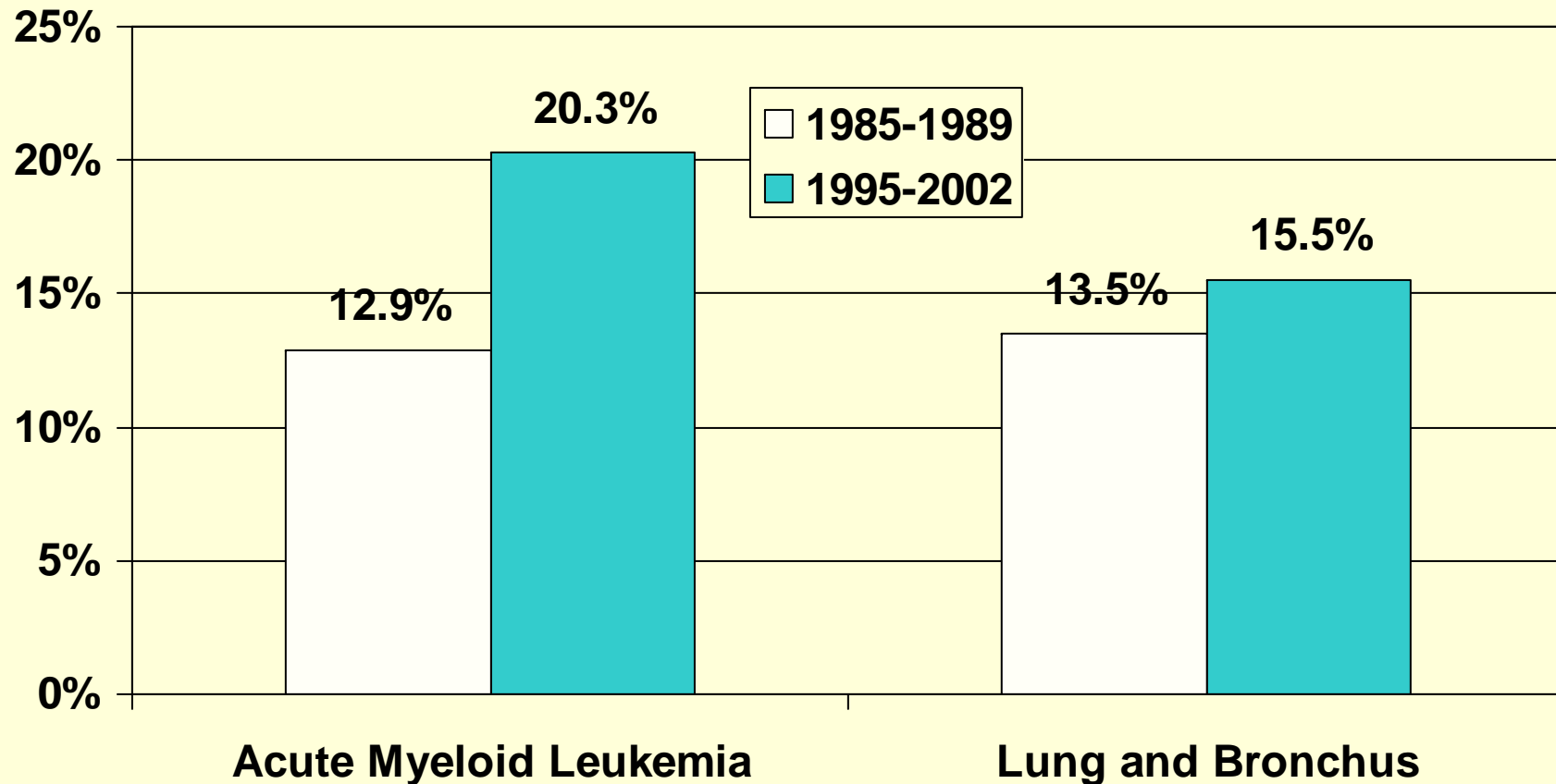
# New goods and economic growth

- Economists believe that the development of new products is the main reason why people are better off today than they were several generations ago.
- In their 1993 book, *Innovation and Growth in the Global Economy*, Grossman and Helpman argued that “innovative goods are better than older products simply because they provide more ‘product services’ in relation to their cost of production.”
- In their 1996 book, *The Economics of New Goods*, Bresnahan and Gordon stated simply that “new goods are at the heart of economic progress.”
- In a recent paper, *Measuring the Growth from Better and Better Goods*, Bils (2004) makes the case that “much of economic growth occurs through growth in quality as new models of consumer goods replace older, sometimes inferior, models.”
- In several papers, I have presented evidence that the introduction and use of new drugs has improved people’s health and increased longevity.

# Analysis A

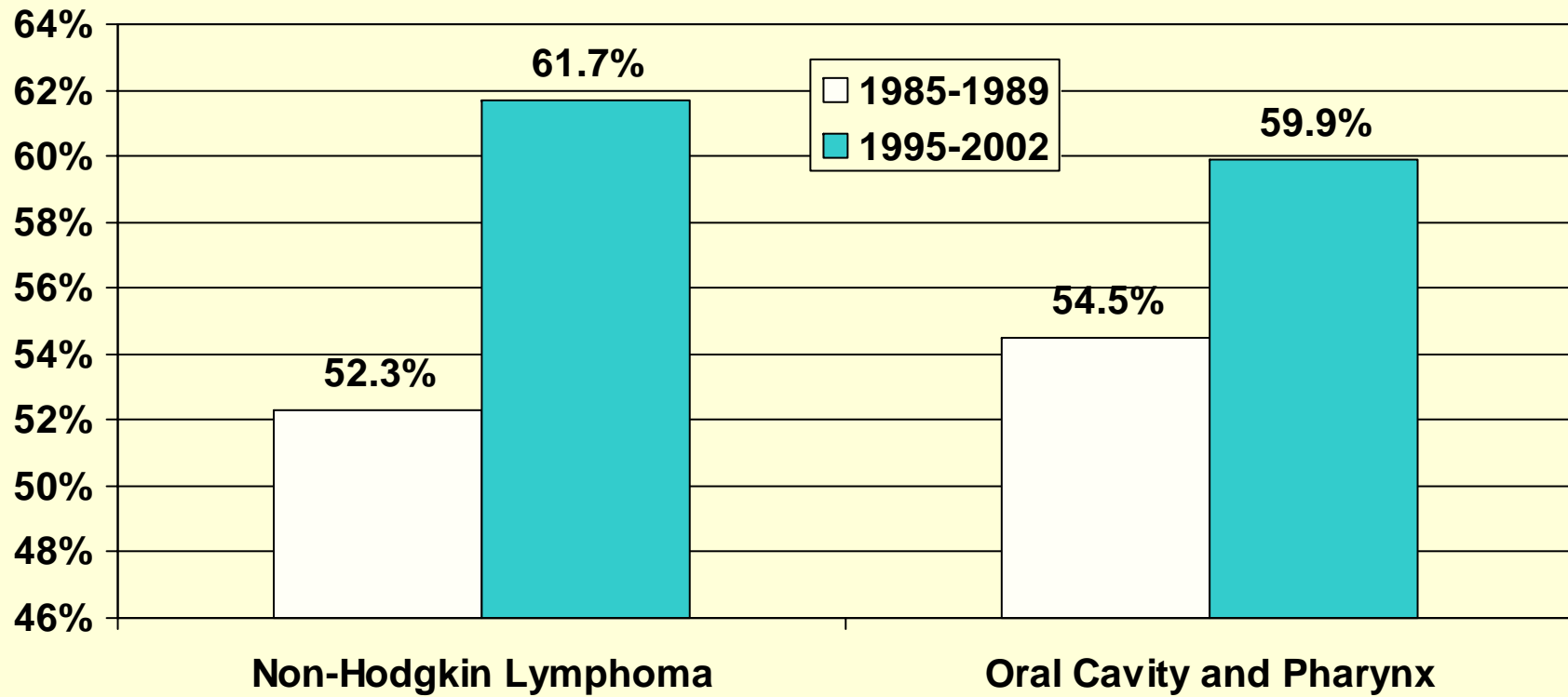
- The first analysis used data on cancer drug vintage, survival, and other variables, by primary cancer site and year, for U.S. cancer patients during the period 1992-2002.

# 5-year relative survival rate



Source: Surveillance, Epidemiology, and End Results (SEER) Program ([www.seer.cancer.gov](http://www.seer.cancer.gov)) SEER\*Stat Database: Incidence - SEER 17 Regs Public-Use, Nov 2005 Sub (1973-2003 varying), National Cancer Institute, DCCPS, Surveillance Research Program, Cancer Statistics Branch, released April 2006, based on the November 2005 submission.

# 5-year relative survival rate



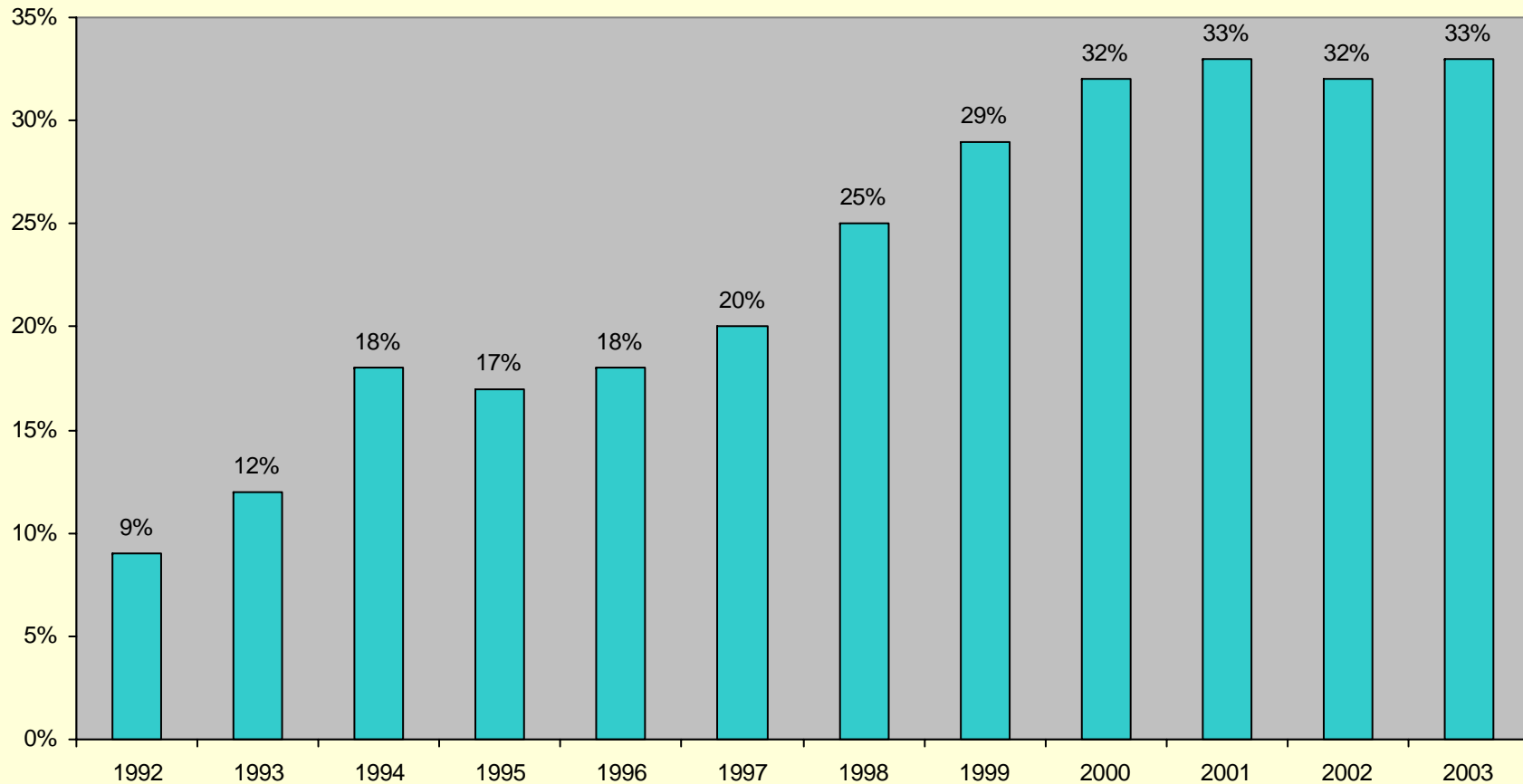
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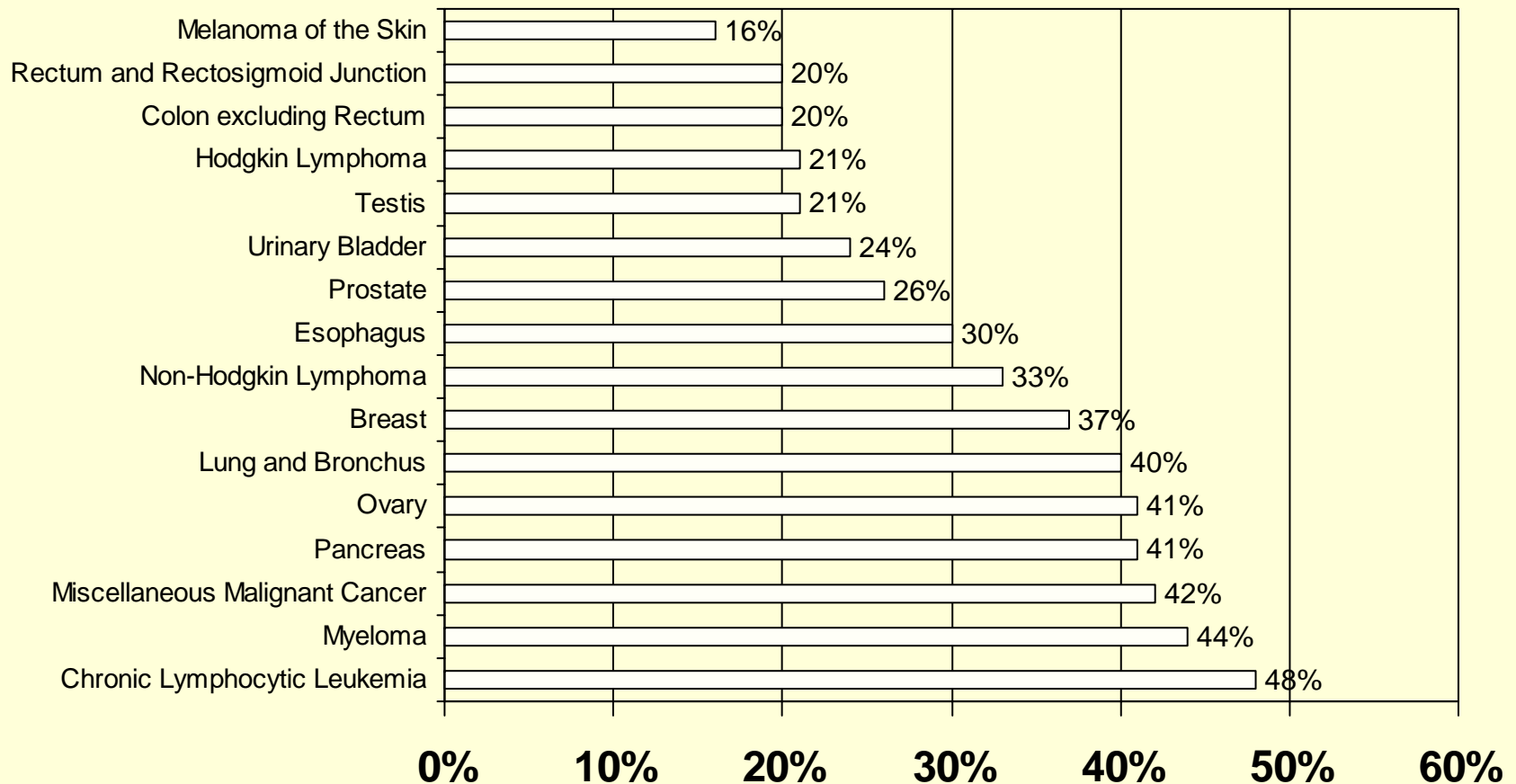
# Top 10 Chemotherapy procedures in MEDSTAT database in 2003

Chemotherapy procedure	number of treatments	total expenditure
J9190-Fluorouracil Injection	25,578	\$444,502
J9265-Paclitaxel Injection	11,587	\$13,500,000
J9000-Doxorubic HCl 10 Mg VI Chemo	10,445	\$3,940,000
J9045-Carboplatin Injection	10,082	\$11,700,000
J9170-Docetaxel	9,982	\$16,400,000
J9355-Trastuzumab	9,175	\$11,000,000
J9201-Gemcitabine HCl	8,118	\$7,840,000
J9206-Irinotecan Injection	6,071	\$9,720,000
J9310-Rituximab Cancer Treatment	5,275	\$18,200,000
J9390-Vinorelbine Tartrate/10 Mg	4,998	\$2,260,000

# Post-1990 drug treatments as % of total drug treatments



# Post-1990 drug treatments as % of total drug treatments in 2003, selected cancer sites



# Other factors controlled for

- “expected survival rate”: the observed survival rate of a comparable (in terms of race, sex, and age) set of people who do not have cancer
- cancer stage distribution (localized, regional, distant)
- the mean age of people diagnosed with cancer
- the number of people diagnosed with cancer
- other medical innovation
  - diagnostic radiology procedure innovation
  - radiation oncology procedure innovation
  - surgical procedure innovation

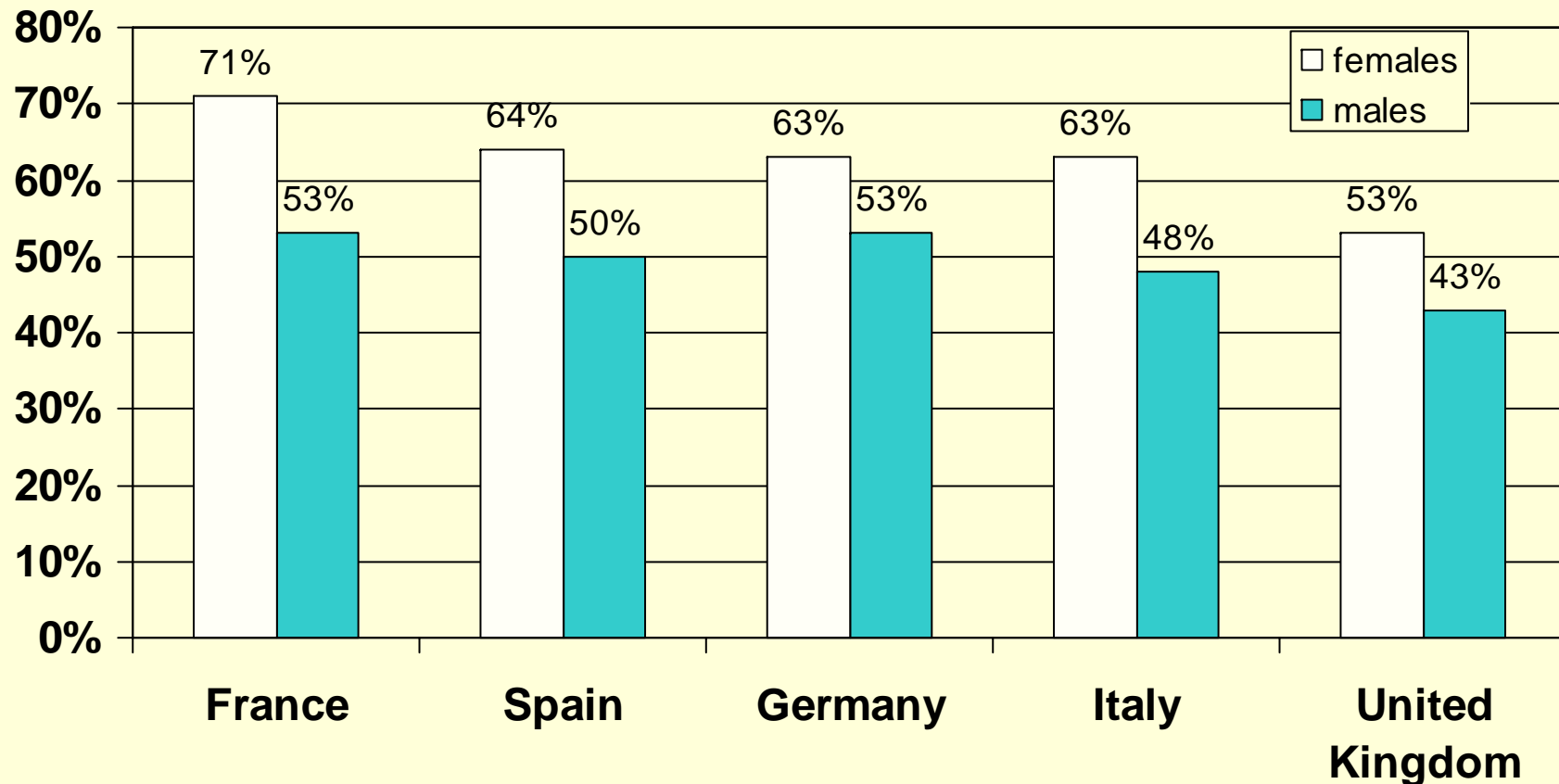
# Analysis A results

- The cancer sites whose drug vintage (measured by the share of post-1990 treatments) increased the most during the 1990s tended to have larger increases in observed survival rates, controlling for other factors.
- Estimates of the fraction of the 1992-1999 change in the observed survival rate that is attributable to the increased utilization of post-1990 drugs ranged from 12% to 121%; the mean of these estimates was 44%.

# Analysis B

- The second analysis used data by primary cancer site and country, for 5 large European countries.

# 5-year survival rate, all sites but non-melanoma skin



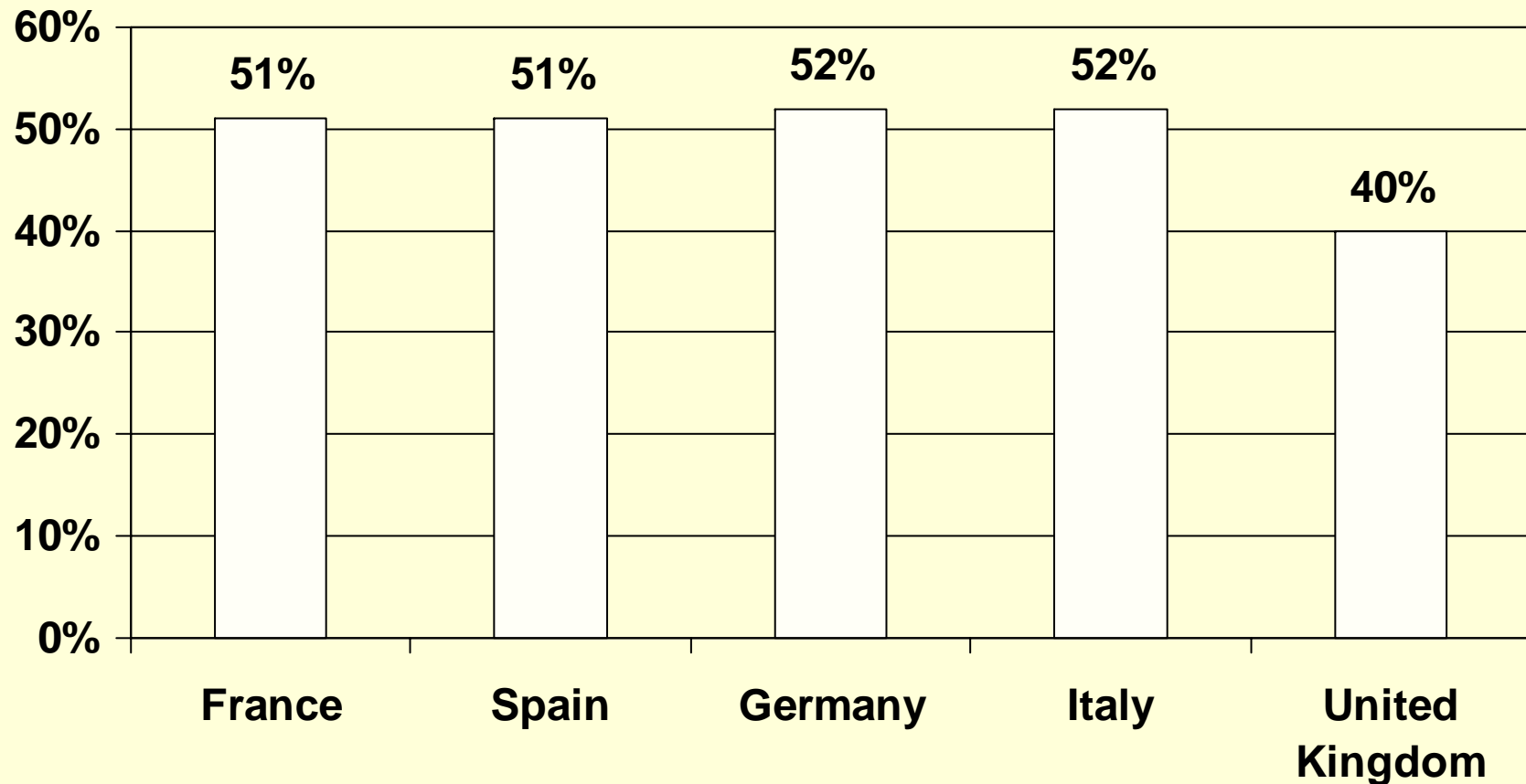
Source: [CANCERmondial Statistical Information System](#)

# 26 drugs for treatment of breast cancer

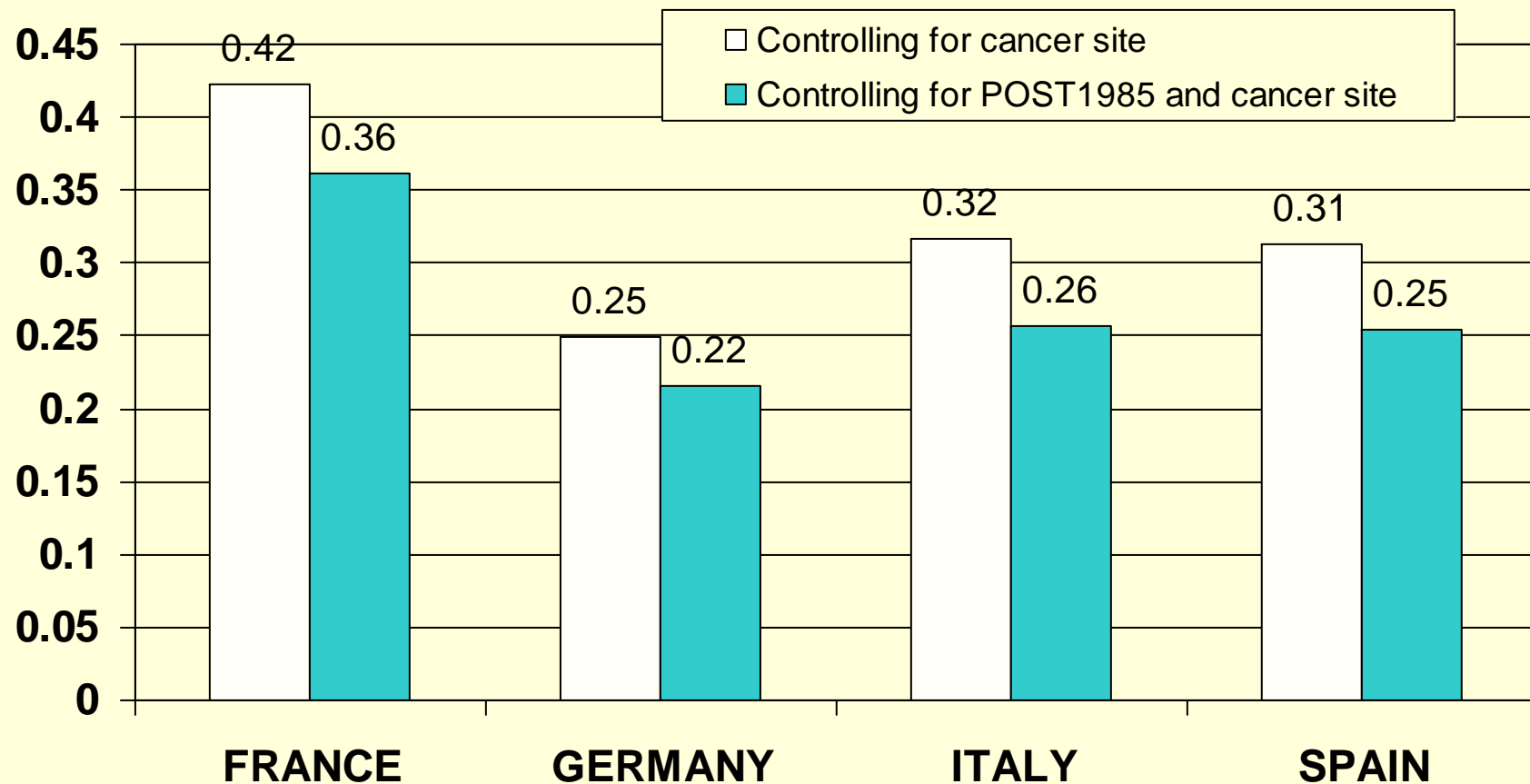
- Anastrozole (3272)
- Capecitabine (3397)
- Cyclophosphamide (0930)
- Docetaxel (3205)
- Doxorubicin Hydrochloride (1112)
- Epirubicin Hydrochloride (3443)
- Estradiol (1188)
- Ethinyl Estradiol (1216)
- Exemestane (3455)
- Fluorouracil (1319)
- Fulvestrant (3553)
- Goserelin Acetate (1382)
- Letrozole (3330)
- Megestrol Acetate (1716)
- Methotrexate Sodium (1770)
- Methyltestosterone (1795)
- Nandrolone Phenpropionate (1859)
- Paclitaxel (3073)
- Tamoxifen Citrate (2306)
- Testolactone (2317)
- Testosterone Enanthate (2320)
- Testosterone Propionate (2321)
- Thiotepa (2342)
- Toremifene Citrate (3273)
- Trastuzumab (3419)
- Vinblastine Sulfate (2427)



# % of 2002-2006 sample patients treated with drugs launched after 1985, by country



# 5-year survival rate differentials from the U.K.



POST1985 differential accounts for 14-19% of (probit of) survival rate differential.

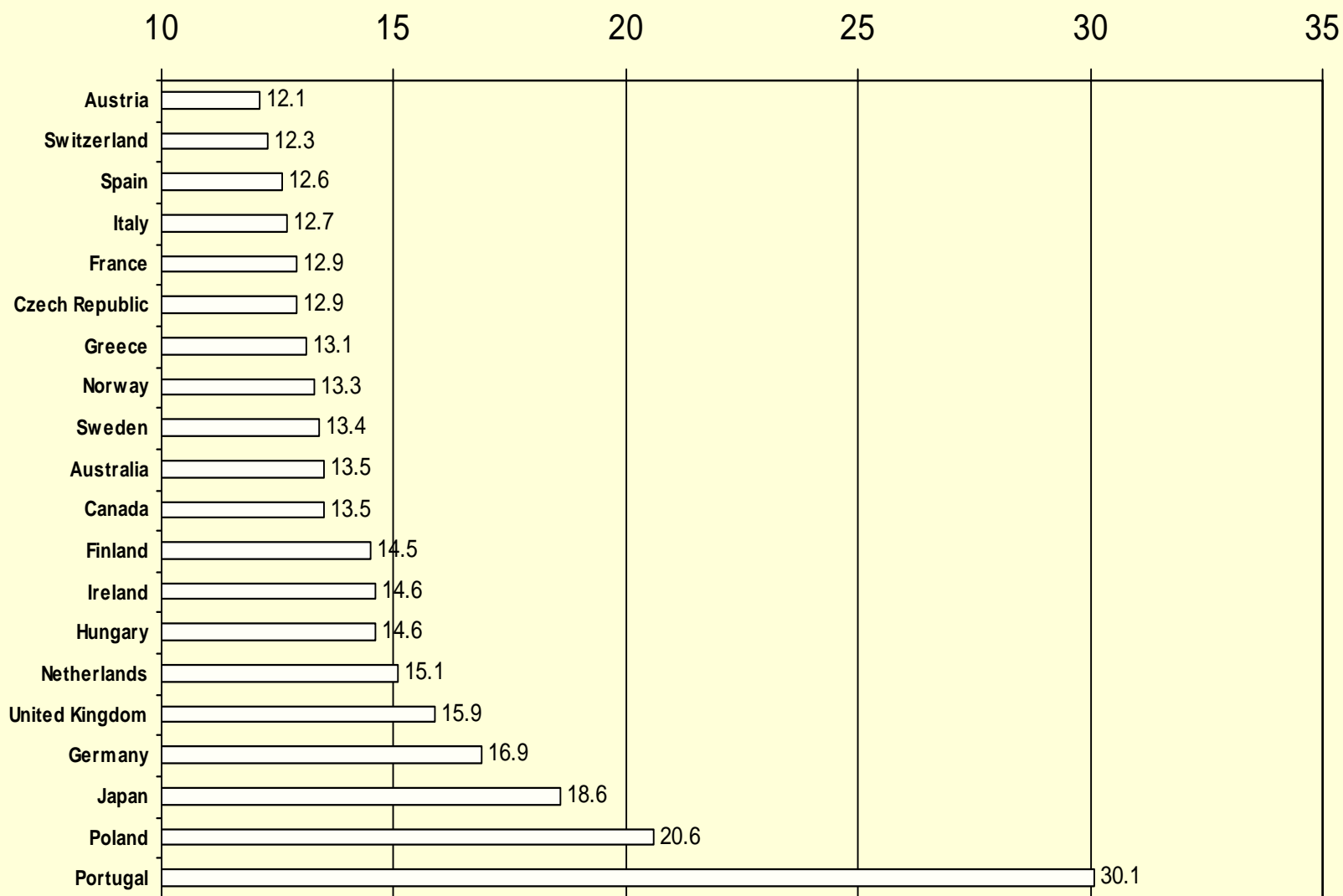
# Analysis B results

- Drug vintage (the share of post-1985 treatments) had a positive and statistically significant effect on both 1-year and 5-year survival rates.
- The difference in the fraction of post-1985 cancer drugs accounted for 14-19% of the 5-year survival rate differential, adjusted for international differences in distribution of cancer sites.
- Since the data on survival and on drug utilization pertain to different time periods, this estimate is probably conservative.

# Analysis C

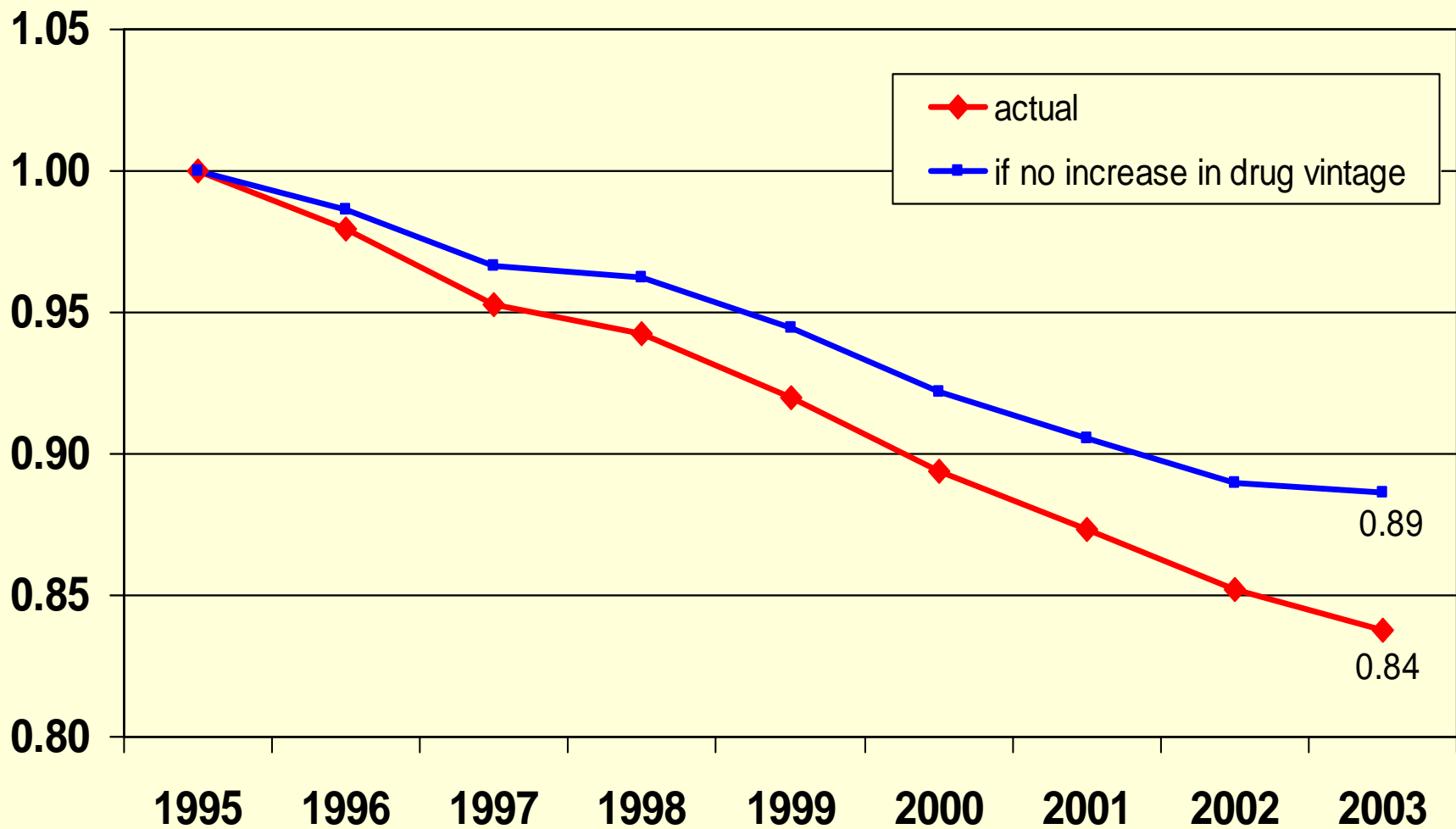
- The third analysis was based on data by country and year, for all cancer sites combined, for 20 countries during the period 1995-2003.

# Mean age of cancer drugs, by country, in 2001



Note: Expenditure-weighted mean.

## Contribution of the increase in cancer drug vintage to the decline in the age-adjusted cancer mortality rate



Increase in drug vintage accounts for 30% of the 1995-2003 decline in the age-adjusted cancer mortality rate.

# Analysis C results

- Countries with larger increases in the mean launch year of cancer drugs had larger declines in the age-adjusted cancer mortality rate.
- A 10-year increase in drug vintage was estimated to reduce the cancer mortality rate by 5.9%, controlling for per capita GDP growth.
- The increase in cancer drug vintage—in other words, the use of newer cancer drugs—accounts for about 30% of the GDP-growth-adjusted decline in the age-adjusted cancer mortality rate.

# Summary

- Cancer survival rates have increased substantially in the last 50 years
- I hypothesized that the development and use of new cancer drugs has made an important contribution to the increase in cancer survival
- I tested this hypothesis by analyzing the relationship between drug vintage (FDA approval year) and cancer survival in 3 different ways, using 3 different kinds of data:
  - Data on cancer cases by primary cancer site and year, for a given country (the U.S.)
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- All three analyses provided support for the hypothesis that, in general, use of new cancer drugs has increased cancer survival rates
- Due to the long-term rise in cancer incidence, cancer drug innovation is likely to play an increasingly important role in public health



# Age-adjusted cancer incidence rate (cases per 100,000 population)

