Evidence that innovative medicines improve health and economic outcomes.

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Evidence that innovative medicines improve health and economic outcomes: focused literature review.

Objective

The purpose of this focused literature review was to identify published evidence supporting a correlation between innovative medicines and improved health and economic outcomes (e.g. measurable mortality and morbidity, healthcare utilization and costs).

Method

A systematic review of published academic studies from 1990 to April 2018 was conducted using the 15 following databases: Academic Search Complete (Ebsco), EconLit (Ebsco), Health & Medical Collection (Proquest), Health Management Database (Proquest), JSTOR, Medline Complete (Ebsco), Psychology and Behavioral Sciences Collection (Ebsco), Psychology Database (Proquest), Public Health Database (Proquest), Science Database (Proquest), ScienceDirect (Elsevier), Social Science Database (Proquest), SpringerLink, Web of Science, Wiley Online Library (John Wiley & Sons). The main keywords searched were pharmaceutical innovation, innovative medicine, new drugs (and various combinations of innovation and prescription, drug, medicine, medication, pharmaceuticals, pharmacotherapy, treatment, therapies), and mortality, morbidity, longevity, life expectancy, healthcare utilization, hospitalizations, health outcomes, work, disabilities, illness, sickness. Reference lists of papers identified were checked to track additional relevant publications. Additional searching was performed with the aid of Google Scholar. Only studies aimed at examining the impact of pharmaceutical innovation on health and economics outcomes, using large population-based data were considered eligible for this literature review. Clinical studies with randomized trials were not included. Only peer-reviewed studies published in academic journals were included. Only studies performed on populations of developed countries were considered eligible. No specification with regard to drug type or therapeutic areas was made. No restriction of time was introduced, although all relevant studies identified were published after 1990. Only studies published in English were considered for this review. Of all articles that were considered to be eligible, a hard copy was retrieved, except for one (Lo & Hsieh, 2014) of which only the abstract was available.

Results

A total of 56 articles were found eligible based upon study design, outcome measures and inclusion criteria. Searching through the reference lists of the retrieved articles yielded 21 additional articles. Upon first stage editorial review 7 studies were excluded for duplication and 2 studies were excluded for irrelevance. A total of 68 studies were considered to have met the inclusion criteria and were relevant to be included in this review. Results are presented in chronological order.

Conclusion

There is abundant literature to support the conclusion that there is a strong positive correlation between pharmaceutical innovation and improved population-level health outcomes and societal-level net economic benefits when examined across therapeutic classes, geographies, demographics and time periods.

Annotated Bibliography

Tracy L. Skaer et al. Economic valuation of Amitriptyline, Desipramine, Nortriptyline, and Sertraline in the management of patients with depression. Current Therapeutic Research, Vol. 56, No. 6, 1995, pp. 556-567.

This study compared health care expenditures for the treatment of depression among 823 American patients enrolled in a health maintenance organization (HMO) who were prescribed either a newer innovative SSRI (sertraline) or one of three older generation tricyclic antidepressants (TCAs). The study controlled for the effect of demographic, clinical, financial, and provider variables on 1-year post-period expenditures for health care. Patients who were prescribed a TCA showed a reduction in expenditures for antidepressant pharmacotherapy, but increased physician and psychiatrist visits, laboratory tests, psychiatric hospitalizations related to the treatment of depression, resulting in a total increase in health care expenditures, while there was a 21% reduction in total health care expenditures for patients on sertraline.

Frank R. Lichtenberg. Do (More and Better) Drugs Keep People Out of Hospitals? American Economic Review, Vol. 86, No. 2, 1996, pp. 384-388.

This American study investigated whether there were greater declines in hospitalisation (measured as hospital bed days) during 1980–1991 for health conditions experiencing more pharmaceutical innovation. It found a strong inverse relationship between the growth in total hospital bed days and the level of pharmaceutical innovation. It estimated that a 10% increase in pharmaceutical expenditure due to innovation was associated with a 6.4% reduction in hospital care expenditure. Since total expenditure on hospital care was 5.7 times as large as total pharmaceutical expenditure, it calculated that a $1 increase in pharmaceutical expenditure was associated with a $3.65 reduction in hospital-care expenditure (ignoring any indirect cost of hospitalization). However, it also found that a $1 increase in drug expenditure was associated with a $1.54 increase in expenditure on physicians' services. There were some indications that mortality rates dropped as a result of new drugs coming on the market during 1980-1991.

Frank R. Lichtenberg. Are the Benefits of Newer Drugs Worth Their Cost? Evidence from the 1996 MEPS. Health Affairs, Vol. 20, No. 5, 2001, pp. 241-251.

This American study used individual-level data in the year 1996 to investigate whether an individual's use of hospital care for a medical condition tended to be lower than average, when the drugs used to treat the condition were newer than average. The study revealed that the use of newer medications was correlated with a lower utilization of hospital care (fewer and shorter hospital stays), and that the higher expenditures entailed by the newer drugs were more than compensated by a larger reduction in hospital expenditures. The study estimated that the average cost of a prescription was $18, which is lower than the observed reduction of $71 in nondrug spending. The study provided evidence that using a newer drug results in a net reduction in the total cost of

treating a given medical condition. The study also found that individuals taking newer prescription drugs were significantly less likely to experience lost workdays than were those consuming older prescription drugs.

Frank R. Lichtenberg (2002). The Effect of Changes in Drug Utilization on Labor Supply and Per Capita Output. NBER Working Paper No. 9139. September 2002.

This American study examined the effect of changes in both the average quantity and average vintage of drugs consumed on labor supply. The estimates indicate that conditions for which there were above-average increases in utilization of prescriptions during 1996-1998 tended to have above-average reductions in the probability of missed work days. The estimated value to employers of the reduction in missed work days exceeded the employer's increase in drug cost. The findings also showed that activity limitations decline at the rate of about 1% per year of drug vintage.

D. N. Bateman et al. The effects of new topical treatments on management of glaucoma in Scotland: an examination of ophthalmological health care. British Journal of Ophthalmology, Vol. 86, No. 5, 2002, pp. 551-554.

The study examined the impact of the introduction of new drugs on clinical care of glaucoma patients in four geographical areas of Scotland for the years 1994-1999. It found that the introduction of new drug classes was associated with a large reduction in operation rates for glaucoma in Scotland over 6 years.

Frank R. Lichtenberg. The effect of new drug approvals on HIV mortality in the US, 1987-1998, Economics & Human Biology. Vol. 1, No. 2, 2003, pp. 259-266.

This American study examined the impact of new drugs on HIV mortality at the aggregate level during the period 1987–1998. This period of analysis was characterized by a rapidly increasing HIV mortality trend followed by a declining HIV mortality trend. The number of HIV deaths more than tripled, from 13,151 in 1987 to 41,388 in 1995. However, this upward-trend was completely reversed in the following 3 years, as deaths caused by HIV dropped to 12,459 in 1998. The study estimated that each additional HIV drug approval reduced yearly HIV deaths by 6093 on average.

Peter Messeri et al. Antiretroviral therapy and declining AIDS mortality in New York City. Medical Care, Vol. 41, No 4, 2003, pp. 512-521.

This study estimated the impact of innovative Highly Active Antiretroviral Therapy (HAART) and other antiretroviral therapy combinations on reducing mortality risk for a cohort of HIV-infected persons living in New York City. It found that mortality rates for the study cohort fell from a high of 131 deaths per 1000 persons/year in 1995 to 31 deaths per 1000 persons/year in 1999. Use of HAART was associated with a 50% reduction in mortality risk.

Frank R. Lichtenberg. Sources of US longevity increase, 1960-2001. Quarterly Review of Economics and Finance, Vol. 44, No. 3, 2004, pp. 369-389.

The study used annual US time-series data on life expectancy, health expenditure, and medical innovation for the period 1960–2001 to estimate the cost per life-year gained (per capita public health expenditure and number of new molecular entities). It found that a permanent 1% increase in per capita health expenditure would lead to a .043% increase in life expectancy at birth, and if one additional drug were approved every year, this would increase longevity by 0.135 years. The estimates imply that the public health expenditure needed to gain one life-year was about US$9640, whereas the pharmaceutical R&D expenditure needed to gain one life-year was only about US$926.

David R. Strutton & John G. Walt. Trends in glaucoma surgery before and after the introduction of new topical glaucoma pharmacotherapies. Journal of Glaucoma, Vol. 13, No. 3, 2004, pp. 221-226.

In the 1990s, advances in pharmacotherapy improved the ability to treat glaucoma without surgery. This paper examined to which extent pharmacotherapy contributed to reducing the number of surgeries for patients who developed the disease. It evaluated the numbers of surgeries for open-angle glaucoma in the US Medicare population before and after the 1996 introduction of the topical lipid glaucoma medication latanoprost. While the number of glaucoma patients remained constant throughout the study period, the number of inpatient and outpatient glaucoma surgeries declined from 1994-1999. In 1999 relative to 1994, the number of annual glaucoma surgeries among unique patients with a diagnosis of glaucoma was reduced by 72% for inpatient procedures and 42% for outpatient procedures. This decreasing trend in the annual number of glaucoma surgeries was associated with the introduction of improved topical pharmacotherapies for the management of glaucoma.

Frank R. Lichtenberg. The Impact of New Drug Launches on Longevity: Evidence from Longitudinal, Disease-Level Data from 52 Countries, 1982–2001. International Journal of Health Care Finance and Economics, Vol. 5, 2005, pp. 47–73.

This study used a large sample that included data on virtually all diseases borne by people in 52 countries during the period 1982–2001. Control variables included education, income, nutrition, the environment, and even lifestyle. Between 1986 and 2000, average life expectancy of the entire population of sample countries increased by 1.96 years. The study found that the incremental cost effectiveness ratio (new drug expenditure per person per year divided by the increase in life-years per person per year attributable to new drug launches) was about $6,750—far lower than most estimates of the value of a statistical life-year.

Frank R. Lichtenberg. Availability of new drugs and Americans' ability to work. Journal of Occupational and Environmental Medicine, Vol. 47, No. 4, 2005, pp. 373-380.

This American study examined the extent to which the introduction of new drugs has increased society's ability to produce goods and services by increasing the number of hours worked per member of the working-age population. It used data on approximately 200,000 individuals with 47 major chronic conditions over a 15-year period (1982–1996). Results indicated that the value of the increase in ability to work attributable to new drugs is 2.5 times as great as expenditure on new drugs.

Frank R. Lichtenberg. The effect of using newer drugs on admissions of elderly Americans to hospitals and nursing homes: state-level evidence from 1997–2003. Pharmacoeconomics, Vol. 24 (Suppl 3), 2006, pp. 5–25.

The study examined the effect of pharmaceutical innovation on the utilization of hospital and long-term care by elderly Americans during 1997–2003. It found that States that had larger increases in drug vintage had smaller increases in the number of hospital discharges per elderly individual. They also had smaller increases in the number of hospital discharges to nursing homes and the number of in-hospital deaths per elderly individual. The study calculated that the 1997-2003 increase in drug vintage was associated with a per capita $1,166 nursing home expenditure reduction and a $785 hospital expenditure reduction.

Tomas J. Philipson & Anupam B. Jena. Who benefits from new medical technologies? Estimates of consumer and producer surpluses for HIV/AIDS drugs. Forum for Health Economics & Policy, Vol. 9, No. 2, 2006, article 3.

This American study decomposed the total lifetime value of HIV/AIDS drugs into consumer surplus, producer surplus (profits), and production costs based on historical statistics. The results indicated that consumers captured about $1.38 trillion, or almost 95% of the net social surpluses (total value net of production costs).

Rodrigo A. Cerda. Endogenous innovations in the pharmaceutical industry. Journal of Evolutionary Economics, Vol. 17, No. 4, 2007, pp. 473-515.

The study tested the hypothesis that the continuous increase in the stock of new drugs marketed in the second half of the 20th century (1950-1997) is related to the continuous decrease in the mortality rate observed in the US population during the same period. By using a sophisticated statistical model that takes into consideration the simultaneity between market size and innovative medicines, it found that the stock of drugs (in 15 important classes) has had a significant negative effect on the mortality rates (in 15 therapeutic categories). In other words, according to the analysis, the increase in the availability new medications during the period has contributed significantly to reducing the mortality rate of the US population.

David M. Cutler et al. The Value of Antihypertensive Drugs: A Perspective on Medical Innovation. Health Affairs, Vol. 26, No. 1, 2007, pp. 97-110.

The study examined the management of chronic high blood pressure through antihypertensive drug therapy, to estimate its impact on the US population over four decades. Data on 5,046 individuals aged 30–79 from a past national health survey (1959–62) and 2,284 individuals aged 40–79 from (1999–2000) were used to estimate blood pressures in the year 2000 in the absence of antihypertensive therapy and were compared with actual, observed blood pressures for that year. After controlling for several factors potentially affecting blood pressure, the study was able to calculate the impact of antihypertensive therapy as the unexplained difference between the predicted and the actual levels of blood pressures in the year 2000. It found that, without antihypertensive therapy, average blood pressure for the US population aged 40 plus in 1999–2000 would have been 10–13% higher. Moreover, 86,000 excess premature deaths from cardiovascular disease (2001) and 833,000 hospital discharges for stroke and heart attacks (2002) would have occurred. Estimates showed that antihypertensive medication is highly cost-effective, with a benefit-to-cost ratio of 6:1 for women and of 10:1 for men.

Bertram Häussler et al. The impact of pharmaceuticals on the decline of cardiovascular mortality in Germany. Pharmacoepidemiology and Drug Safety, Vol. 16, No. 10, 2007, pp. 1167-1176.

This study investigated the extent to which pharmaceuticals and other medical interventions affected mortality from cardiovascular diseases in Germany (1968-2001). The study found that medical interventions, along with improved preventive behaviour, significantly contributed to decreasing cardiovascular mortality in the German population. The consecutive introduction of new classes of pharmaceuticals had an independent effect on reducing mortality.

Frank R. Lichtenberg. The impact of new drugs on US longevity and medical expenditure, 1990–2003: evidence from longitudinal, disease-level data. American Economic Review, Vol. 97, No. 2, 2007, pp. 438–443.

This study examined the effect of changes in the vintage of prescription drugs on US longevity and medical expenditure during the 1990–2003 period, using longitudinal disease-level data. The study used two measures of mortality: the number years of potential life lost before age 65 and the number of years of potential life lost before age 75. It used three measures of healthcare utilization: the number of hospital admissions, the number of hospital discharges to other institutions (nursing homes, rehabilitation facilities) and the number of hospital stays in which the patient died. The study revealed a strong inverse relationship across conditions between pharmaceutical innovation and changes in mortality, hospital admissions, and hospital discharges to nursing homes. It found that the use of post-1990 drugs in 2002 reduced the number of life years lost before age 65 by 1.56 million and the number of life years lost before age 75 by about 1.7 million. The use of post-1993 drugs in 2003 reduced hospital expenditure by $58

billion and nursing home expenditure by $9.5 billion. Finally, the study estimated that the reduction in hospital and nursing home costs was 2.4 times as great as the cost of the drugs.

Frank R. Lichtenberg & Suchin Virabhak. Pharmaceutical-embodied technical progress, longevity, and quality of life: drugs as 'equipment for your health'. Managerial and Decision Economics, Vol. 28, No. 4-5, 2007, 371-392.

This American study tested the hypothesis that newer drugs prolong and improve the quality of life (pharmaceutical-embodied technical progress). The study confirmed that there exists a high rate of pharmaceutical-embodied technical progress. Overall, the study found that people who used newer drugs had better post-treatment health than people using older drugs for the same condition, controlling for pre-treatment health, age, sex, race, marital status, education, income, and insurance coverage. Regression results showed that people were less likely to experience activity or social limitations if they had consumed newer drugs. The study also found that the people in poor initial health are the prime beneficiaries of pharmaceutical innovation. Indeed, the health of people with low levels of education tends to be worse than the health of people with more education. Therefore, the study concluded that pharmaceutical innovation may contribute not only to promoting economic growth, but to reducing inequalities as well.

Frank R. Lichtenberg. Pharmaceutical innovation and US cancer survival, 1992–2003: evidence from linked SEER-MEDSTAT data. Forum for Health Economics & Policy, Vol. 10, No. 1, 2007, article 1.

This American study examined the impact of pharmaceutical innovation on cancer survival using innovation measures based on drug utilization data. Specifically, it investigated whether increases in the proportion of new chemotherapy treatments in any given cancer sites influenced cancer survival rates of diagnosed patients. The study included measures of innovation in other drug treatments, surgical procedures, diagnostic radiology procedures, and radiation oncology procedures. The study revealed that the largest increases in survival rates were observed on cancer sites whose share of new chemotherapy drug treatments (approved after 1990) increased the most during the period 1992-2003, all other factors held constant. Also, it found that 74% of the increase in the 1-year observed survival rate for all cancer sites combined during the period 1992-2001 was due to chemotherapy innovation. Chemotherapy innovation was responsible for 51% and 29%, respectively, of the observed improvements in the 2-year and 3-year cancer survival rates.

Frank R. Lichtenberg. Benefits and costs of newer drugs: an update. Managerial and Decision Economics, Vol. 28, 2007, pp. 485-490

The study used data on the entire US population for the years 1996-1998 and found that reducing the average age of drugs used to treat a medical condition from 15 years to 5.5 years increased prescription drug spending by $18 but reduced other medical spending by $129, yielding a $111 net reduction in total health spending. The use of newer more innovative drugs reduced non-drug expenditure by 7.2 times as much as it increased drug expenditure. The study also looked more narrowly at the Medicare population and found that in the Medicare population, a reduction in the age of drugs utilized reduced non-drug expenditure by all payers (public and private) 8.3 times as much as it increased drug expenditure and it reduced Medicare non-drug expenditure 6.0 times as much as it increased drug expenditure. About two-thirds of the non-drug Medicare cost reduction was due to reduced hospital costs. The remaining third was approximately evenly divided between reduced Medicare home health care cost and reduced Medicare office-visit costs.

Yutin Zhang & Stephen B. Soumerai. Do newer prescription drugs pay for themselves? A reassessment of the evidence. Health Affairs, Vol. 26, No. 3, 2007, pp. 880-886.

This American study attempted to replicate the findings of Lichtenberg on the value of pharmaceutical innovation using four additional and cumulative model specifications: updating the data on drug vintages; calculated drug spending associated with medical conditions; controlled for the severity of illnesses; and tested alternative model specifications. It concluded that the development of new medications can still provide net benefits to society, even without a cost offset. Some medications might have important advantages compared to older drugs, such as higher life expectancy, better health outcomes, or reduced sick days, even if they do not produce overall cost reductions.

Mark G. Duggan & William N. Evans. Estimating the Impact of Medical Innovation: A Case Study of HIV Antiretroviral Treatments. Forum for Health Economics & Policy, Vol. 11, No. 2, 2008, art. 1.

This study used several years of claims, eligibility, and mortality data from California's Medicaid program to estimate the effect of new HIV antiretroviral treatments (ARVs) on both healthcare spending and health outcomes. It estimated the average effect of a new treatment soon after its introduction and how the effect varies across individuals. It found evidence of lower expenditures and reduced mortality risks.

Chee-Ruey Hsieh & Frank A. Sloan. Adoption of pharmaceutical innovation and the growth of drug expenditure in Taiwan: Is it cost effective? Value in Health, Vol. 11, No. 2, 2008, pp. 334-344.

The study examined the impact of adopting pharmaceutical innovations on the growth of pharmaceutical expenditures, focusing specifically on Taiwan's experience. Cost per life-year gained resulting from introduction of new drugs was only US$1,053 (2003 dollars) from the perspective of the public payer and US$1,824 from the perspective of society as a whole.

Geoffrey F. Joyce et al. Impact of specialty drugs on use of other medical services. American Journal of Managed Care, Vol. 14, No. 12, 2008, pp. 821-828.

This American study examined the hypothesis that the cost of using specialty drugs for the treatment of two autoimmune disorders (rheumatoid arthritis and multiple sclerosis) could be offset by a decrease in medical spending elsewhere in the healthcare sector (number of hospitalizations, physician office visits and expensive procedures). It found that starting a biologic for the treatment of RA or MS was associated with lower use of some types of medical services within two to three years of initiation.

Frank R. Lichtenberg & Gautier Duflos. Pharmaceutical innovation and the longevity of Australians: A first look. In Lorens Helmchen, Robert Kaestner, Anthony Lo Sasso (ed.) Beyond Health Insurance: Public Policy to Improve Health, Emerald Group Publishing Limited, 2008, pp. 95 – 117.

The study measured the extent to which newer drugs were associated with reductions in mortality in Australia between 1995 and 2003. It found that the mean age at death increased more for diseases with larger increases in mean drug vintage. A 5-year increase in mean drug vintage is estimated to increase mean age at death by almost 11 months. Also, the use of newer drugs increased life expectancy by 1.23 years and increased lifetime drug expenditure by about $13,000. Considering the value of a statistical Australian life-year ($71,000), this means that the value of increased life expectancy is about 7 times as large as the associated cost estimate.

Frank R. Lichtenberg, Paul Grootendorst, Marc Van Audenrode, Dominick Latremouille-Viau, Patrick Lefebvre. The Impact of Drug Vintage on Patient Survival: A Patient-Level Analysis Using Quebec's Provincial Health Plan Data. Value in Health, Volume 12, Number 6, 2009.

The study evaluated the impact of drug innovation on the longevity of Canadians using patient-level claims data from Quebec's provincial health plan for elderly patients with continuous health coverage dispensed at least one drug prescription in each year of the study period, 1997-2006. It controlled for year indicator variables, patient age, sex, region of residence, low income status, medical services use, concomitant drug use, and comorbidities. The use of newer medications was associated with a statistically significant mortality risk reduction relative to older medications. This analysis showed that recent drug innovation has had a significant beneficial impact on the longevity of elderly patients.

Frank R. Lichtenberg. Have newer cardiovascular drugs reduced hospitalization? Evidence from longitudinal country-level data on 20 OECD countries 1995-2003. Health Economics, Vol. 18, 2009, pp. 519-534.

This study examined the effect of changes in the age of cardiovascular drugs on hospitalization and mortality from cardiovascular disease in 20 OECD countries during the period 1995–2004. In addition to cardiovascular drug vintage, the models of cardiovascular hospitalization and mortality that were estimated by the study include several other explanatory variables: the quantity of cardiovascular medications consumed per person, the level of use of other medical innovations, some indicators of potentially important cardiovascular risk factors (calories consumed per person per day, per capita expenditure on tobacco and alcohol), and demographic variables (population size and age structure, income, and education level). The study revealed that using newer cardiovascular drugs reduced the hospital average length of stay and the (age-adjusted) mortality rate from cardiovascular disease worldwide. The mean vintage of cardiovascular drugs increased during the period 1995–2004: on average, almost 10% of cardiovascular drugs used in 2004 had been marketed after 1995 and almost 15% after 1990. In the absence of an increase in the use of newer drugs during 1995-2004, the rise in per capita expenditure for cardiovascular hospital stays ($89) would have been about 3.7 times as large as the reduction in per capita expenditure that would have occurred for cardiovascular drugs ($24).

Frank R. Lichtenberg. The effect of new cancer drug approvals on the life expectancy of American cancer patients, 1978-2004. Economics of Innovation and New Technology, Vol. 18, No. 5, 2009, pp. 407-428.

This study sought to evaluate the effect of new cancer drugs on the life expectancy of cancer patients in the United States. The study estimated that the life expectancy of cancer patients increased by almost a year (0.94 years) as a result of the introduction of new cancer drugs during the period 1968–1994. Considering that the lifetime risk of being diagnosed with cancer is about 40%, the study deduced that the increase in the lagged stock of cancer drugs during 1978–2004 increased the life expectancy of the entire US population by 0.38 years (= 40% ∗ 0.94 years). This represents 8.8% of the increase in life expectancy at birth observed in the US population from 1978 (73.5 years) to 2004 (77.8 years).

Frank R. Lichtenberg. International differences in cancer survival rates: the role of new drug launches. International Journal of Healthcare Technology and Management, Vol. 10, No. 3, 2009, pp. 138-155.

The study used data on 17 different types of cancer (breast cancer, colon cancer, leukemia, etc.) in 38 countries. The model controlled for all determinants of cancer survival that are invariant across cancer types within a given country, and that are invariant across countries for a given cancer type. The study estimated that increasing the number of drugs from 9 to 30 would increase the 1-year survival rate by 3.0% points, and it would increase the 5-year survival rate by 2.2% points. Comparing the results to those of previous studies, the study concluded that access to new drugs explains a larger fraction of the time-series variation in longevity than it does of the international variation in longevity.

Frank R. Lichtenberg. Chapter 15: Home or Nursing Home? The Effect of Medical Innovation on the Demand for Long-Term Care. In Joan Costa-Font, Christophe Courbage, and Alistair McGuire (eds.), The Economics of New Health Technologies: Incentives, Organization, and Financing, Oxford University Press, 2009, pp. 241-258.

The study measures the contribution of pharmaceutical and medical procedure innovation in reducing the age-adjusted nursing-home residence rate. Using data were obtained from the National Nursing Home Survey, the Medical Expenditure Panel Survey, MEDSTAT, and other sources, it estimates that diseases with more rapid rates of pharmaceutical innovation had larger declines in the nursing-home residence rate during the period 1985-1999. About three quarters of the declining rate of people aged 65 and over was associated with pharmaceutical innovation, versus about 56% for seniors aged 80 and over.

Frank R. Lichtenberg. Has medical innovation reduced cancer mortality? NBER Working Paper No. 15880. April 2010.

Examined the effects of diagnostic imaging innovation and pharmaceutical innovation and cancer incidence rates on US cancer mortality rates during the period 1996-2006. There was a significant inverse relationship between the cancer mortality rate and both lagged imaging innovation and contemporaneous drug innovation, and a significant positive relationship between the cancer mortality rate and the lagged incidence rate. Imaging innovation, drug innovation, and declining incidence jointly explained about three-fourths of the decline in cancer mortality. About one-fourth of the mortality decline was attributable to drug innovation. Life expectancy at birth may have been increased by almost three months between 1996 and 2006 by the combined effects of cancer imaging and cancer drug innovation.

Van Bui & Michael Stope. The impact of new drug launches on the loss of labor from disease and injury: evidence from German panel data. International Journal of Health Care Finance and Economics, Vol. 10, No. 4, 2010, pp. 315-346.

The study examined the evolution of premature retirement caused by disease and injury in the German labor force from 1988-2004 and found that new drug launches in the country reduced the loss of labor over the period. It was estimated that each launch of a new medicine for the treatment of specific diseases in Western Germany led to a reduction of the number of lost working years by around 200 working years annually, after controlling for a series of factors such as age, sex, type of work, diagnosis, utilization of rehabilitation services and the impact of the 2001 pension reform. The study also estimated, based on the average monthly disability pensions for men and women, that these work-loss days avoided represent a financial gain to the public pension system amounting to €140 million annually.

Abdülkadir Civan & Bülent Köksal. The effect of newer drugs on health spending: Do they really increase the costs? Health Economics, Vol. 19, 2010, pp. 581-595.

Using a panel of US state-level data, the study tested whether improvement in medical technologies in general, and pharmaceutical products in particular, actually increase overall health care spending. The conclusion is that pharmaceutical products are substitutes to hospitalization. More importantly, newer drugs are more efficient substitutes, in the sense that they reduce expenditures for any episode of care. The effect of this substitution is larger than the effect of expansion of treatment (i.e. the new technologies induce a greater demand for care which – on the whole – increase spending).

Seema Jayachandran, Adriana Lleras-Muney & Kimberly V. Smith. Modern medicine and the twentieth century decline in mortality: evidence on the impact of sulfa drugs. American Economic Journal: Applied Economics, Vol. 2, No. 2, 2010, pp. 118-146.

This study examines the impact of sulfa drugs on declines in US mortality. It found that sulfa drugs led to a 24 to 36% decline in maternal mortality, 17 to 32% decline in pneumonia mortality, and 52 to 65% decline in scarlet fever mortality between 1937 and 1943. Altogether, sulfa drugs reduced mortality by 2 to 3% and increased life expectancy by 0.4 to 0.7 years.

Frank R. Lichtenberg. The effect of drug vintage on survival: Micro evidence from Puerto Rico's Medicaid program. In Avi Dor (ed.), Pharmaceutical Markets and Insurance Worldwide, Emerald Group Publishing Limited, 2010, pp. 273-292.

Using data on virtually all of the drugs and diseases of over 500,000 people enrolled in Puerto Rico's Medicaid program, the study examined the impact of new drugs on the patient's three-year probability of survival, controlling for demographic characteristics (age, sex, and region), utilization of medical services, and the nature and complexity of illness are examined. It found that people using newer drugs experienced lower mortality rates.

Jason Schinttker & George Karandinos. Methuselah's medicine: Pharmaceutical innovation and mortality in the United States, 1960-2000. Social Science & Medicine, Vol. 70, No. 7, 2010, pp. 961-968.

The study indicates that a 10% increase in innovation leads to a 0.029 year increase in life expectancy at birth when controls for GDP are introduced. This demonstrates that GDP has a larger association with life expectancy than new molecular entity (NME), but NME approvals nevertheless are significantly related to improvements in life expectancy. The results also revealed the importance of population aging for understanding the impact of medical innovation. The interaction between year and NME approvals was statistically significant for all age groups over age 54, but only for one age group under 55 (45–49).

Frank R. Lichtenberg. Has pharmaceutical innovation reduced social disability growth? International Journal of the Economics of Business, Vol. 18, No. 2, 2011, pp. 293-316.

This American study investigated the extent to which newer prescription drugs contributed to reducing the share of workers receiving social security disability insurance (DI recipients). This analysis was performed using longitudinal state-level data for the period 1995-2004. A linear regression model estimated DI recipient rates using prescription vintages calculated at the state level, fixed effects for year and state, and control variables such as age, wages, schooling, labour force participation, and health conditions. From 1995 to 2004, the actual disability rate increased 30% in the United States (from 2.6% to 3.4%). In the absence of any post-1995 increase in drug vintage, the increase in the disability rate would have been 30% larger: the disability rate would have increased by 39%, to 3.65%. The study estimated that in the absence of new drugs (marketed after 1995), the proportion of people constrained by disability in the US would have been 30% higher than its actual level, and that some 418,000 additional working-age Americans would have received public disability insurance benefits.

Frank R. Lichtenberg. The quality of medical care, behavioral risk factors, and longevity growth. International Journal of Health Care Finance and Economics, Vol. 11, No. 1, 2011, pp. 1-34.

This study investigated the effects of the quality of medical care, behavioral risk factors (e.g., obesity and smoking), disease incidence, income, education and insurance coverage on longevity and per capita medical expenditure. It measured these effects by analysing longitudinal state-level data for the United States between 1991 and 2004. It found that states with larger increases in the use of newer drugs have seen the largest increases in life expectancy of their population. On the other hand, these states did not have larger increases in per capita medical expenditure. The study concluded that this result contradicts the perception according to which pharmaceutical (and medical) innovation has contributed to rising total healthcare spending in the US.

Dave E. Marcotte & Sara Markowitz. A Cure for Crime? Psycho-Pharmaceuticals and Crime Trends. Journal of Policy Analysis and Management, Vol. 30, No. 1, 2011, pp. 29-56.

The study notes the considerable drop in (especially violent) US crime rates in the1990s. At the same time, the use of antidepressants and antipsychotics was becoming increasingly common following a series of innovations in the pharmaceutical sector. Among these new drugs were SSRIs such as Prozac in 1988, Zoloft in 1992, and Paxil in 1993, and newer generation antidepressants (NGAs) such as Trazodone and Wellbutrin, approved in 1988 and 1989, respectively. The study found evidence that the expansion of psychiatric drugs is associated with decreased violent crime rates, but not property crime rates. They evaluated that the arrival of newer antidepressants has reduced the total number of violent crimes committed by just over 15,000. Since the total number of violent crimes reported to police declined by 300,000 during the study period, these

estimates imply that about 5% of the decline was due to expanded mental health treatment.

Rexford E. Santerre. National and international tests of the new drug cost offset theory. Southern Economic Journal, Vol. 77, No. 4, 2011, pp. 1033-1043.

This study used American data to demonstrate that pharmaceutical spending slows the growth rate of spending on medical services at the margin. It found that any additional new drug raises spending on pharmaceuticals in the short run by $1.02 on a per capita basis, while the net overall savings amount to $5.91. This implies that one additional new drug produces net medical cost savings of approximately between $1.8 billion and $3.4 billion in the long run. The study was replicated with 7 other OECD countries and found similar results. The empirical findings indicate that the typical drug reduces the growth of total medical care spending by 0.065% points in the short run and by 0.087% points in the long run.

Craig L. Garthwaite. The economic benefits of pharmaceutical innovations: the case of Cox-2 inhibitors. American Economic Journal: Applied Economics, Vol. 4, No. 3, 2012, pp. 116-137.

The study evaluated to which extent the increased use of Cox-2 inhibitors, which are nonsteroidal anti-inflammatory drugs, may have improved labour force participation in the United States. To do so, it used an external event, the sudden removal of Vioxx from the market in 2004 in response to concerns over negative side effects. Such analyses are rare, because it is difficult to pinpoint specific moments for which there is a society-wide change in medical technology (natural experiment). At the time of the removal, about 1.3 million Americans were using this medication, the most widely prescribed Cox-2 inhibitor. The study used data from the Medical Expenditure Panel Survey (MEPS) to estimate the effect of Vioxx's removal on the labor supply of individuals with chronic joint conditions. It found that the removal decreased the probability of working for an affected individual by 22%, resulting in $19 billion lost in wages in the year following the withdrawal.

David C. Grabowski et al. The large social value resulting from use of statins warrants steps to improve adherence and broaden treatment. Health Affairs, Vol. 31, No. 10, 2012, pp. 2276-2285.

This study estimated the health benefits generated by statins at the US population level and the social value of these gains for consumers and producers. The study revealed that statin therapy produces substantial value. Specifically, using real-world population data, the study found that therapy decreased low-density lipoprotein levels by 18.8%. Had statin therapy not been available for patients, approximately 40,000 more deaths, 60,000 more heart attacks, and 22,000 more strokes would have occurred in 2008. Considering the mortality benefits alone, over the period 1987– 2008, statin therapy generated an estimated surplus of $947.4 billion for people initiating the treatment.

Frank R. Lichtenberg. The Effect of Pharmaceutical Innovation on the Functional Limitations of Elderly Americans: Evidence from the 2004 National Nursing Home Survey. In Kristian Bolin, Robert Kaestner (ed.) The Economics of Medical Technology (Advances in Health Economics and Health Services Research, Volume 23) Emerald Group Publishing Limited, 2012, pp. 73 – 101.

Functional disability of elderly people has declined significantly over time. Many factors could explain this decline, including medical and pharmaceutical innovation such as intensive treatment for heart disease, increased use of anti-inflammatory drugs for arthritis treatment, and advances for treating mental illness. The study evaluates how changes over time in the ability of nursing home residents to perform activities of daily life were associated with medication attributes, controlling for patient diagnosis, facility, and demographic characteristics. The study finds that pharmaceutical innovation was associated with a 1.2% - 2.1% decrease in functional limitations of nursing home residents between 1990 and 2004.

Frank R. Lichtenberg. Contribution of pharmaceutical innovation to longevity growth in Germany and France, 2001-2007. Pharmacoeconomics, Vol. 30, No. 3, 2012, pp. 197-211.

This study investigated the effect of the vintage of prescription drugs (and other variables) on the life expectancy and age-adjusted mortality rates of residents of Germany and the effect of the vintage of chemotherapy treatments on age-adjusted cancer mortality rates of residents of France, using longitudinal region- or disease-level data. For Germany, the study revealed that states with larger increases in drug vintage (more newer drugs) had larger increases in longevity, after controlling for some other potentially important determinants of life expectancy (diagnostic imaging innovation; per capita quantity of drugs consumed; per capita income; the unemployment rate; the notifiable disease rate; the AIDS case rate; the number of physicians, pharmacists and hospital beds). The study also found that life expectancy increased by 1.4% during the period 2001-2007, the third (32%) of which was attributable to the use of newer drugs (as measured by the increase in drug vintage). For France, the study found that cancer sites for which there were larger increases in chemotherapy vintage had larger reductions in the age-adjusted mortality rate. Moreover, the study estimated that the increase in drug vintage reduced the age-adjusted cancer mortality rate by between 1% and 3% during 2002– 2006. The two scenarios estimated by the study imply that between about one-sixth and one-half of the total decline in the age-adjusted mortality rate observed can be explained by the availability of new chemotherapy agents in the country.

Frank R. Lichtenberg, The Effect of Pharmaceutical Innovation on Longevity: Patient Level Evidence from the 1996–2002 Medical Expenditure Panel Survey and Linked Mortality Public-use Files. Forum for Health Economics & Policy, Vol. 16, No. 1, 2013.

This study examined the effect of newer prescription drugs used by an individual on his or her survival and medical expenditure, controlling for a number of demographic characteristics and indicators and determinants of health status (e.g. race, education, family income, insurance coverage, medical condition, marital status, etc.). It used data on a nationally representative sample of elderly US community residents during the period 1996-2002. The study found that a 1-year increase in the vintage of a drug increased life expectancy for the US elderly by 0.52%, after controlling for individual attributes. Not less than two-thirds of the 0.6-year increase in the life expectancy of elderly Americans during 1996-2002 was due to the increase in drug vintage. The 1996-2002 increase in drug vintage is also estimated to have increased annual drug expenditure per elderly American by $207, and annual total medical expenditure per elderly American by $218. This implies that the incremental cost-effectiveness ratio (cost per life-year gained) of pharmaceutical innovation was about $12,900.

Frank R. Lichtenberg. The impact of new (orphan) drug approvals on premature mortality from rare diseases in the United States and France, 1999-2007. European Journal of Health Economics, Vol. 14, No. 1, 2013, pp. 41-56.

The study tested whether new orphan drugs entering the market led to reductions in premature mortality from rare diseases. It used longitudinal, disease-level data for two developed countries, the United States and France, during 1999-2007. Both the US and French estimates indicated that, overall, premature mortality from rare diseases was unrelated to the cumulative number of drugs approved 0–2 years earlier but was significantly inversely related to the cumulative number of drugs approved 3–4 years earlier. The study argues that this result is explained by the fact that most patients probably do not have access to a drug until several years after it has been launched. It suggests that patients would benefit from gaining faster access to orphan drugs and could lead to larger decreases in the number of premature deaths from rare diseases.

Apostolos Tsiachristas, René Goudriaan & Wim Groot. The welfare effects of innovative pharmaceuticals: an international perspective from the Dutch experience. Applied Economics, Vol. 45, No. 9, 2013, pp. 1219-1226.

The study examined the welfare gains of pharmaceutical innovation in the Netherlands. Based on the medicines in their sample, total welfare gains were estimated at €1.3 billion in 2006 (€163 million for Lower scenario and €2.7 billion for the Upper scenario). This is about 0.2% of the Dutch GDP in 2006 and about 23% of the Dutch pharmaceutical spending in the same year, or between €10 and €163 per capita. Further, the study estimated that approximately €729 million in welfare gains were not realized due to delays in the introduction of new medicines.

Frank R. Lichtenberg. The impact of pharmaceutical innovation on longevity and medical expenditure in France, 2000-2009. Economics and Human Biology, Vol. 13, 2014, pp. 107-127.

The study used longitudinal, disease-level data to determine the extent to which pharmaceutical innovation has contributed to greater longevity in France during the years 2000-2009. It also measured the associated trade-offs in terms of drug and pharmaceutical costs. Pharmaceutical innovation increased mean age at death by 0.29 years between 2000-2009, which represents about one-fifth of the total increase in longevity. It was also estimated that per-capita pharmaceutical expenditure increased by $125 (26%) in 2009 as a result of drug innovation, but most (87%) of this increase was offset by a reduction in hospital expenditure. The observed increase in longevity was smaller in France than in other countries where the rate of new-drug adoption has been greater. Therefore, from a public policy perspective, the study concluded that laws placing strict limits on pharmaceutical reimbursement, are likely to diminish incentives for new drug development in the long run and penalize patients.

Frank R. Lichtenberg and Billie Pettersson. The impact of pharmaceutical innovation on longevity and medical expenditure in Sweden, 1997–2010: evidence from longitudinal, disease-level data. Economics of Innovation and New Technology, Vol. 23, No. 3, 2014, pp. 239-273.

The study assessed the impact of pharmaceutical innovation on longevity, hospital utilization, and medical expenditure in Sweden during the period 1997–2010. Using longitudinal, disease-level data, it investigated whether the diseases that experienced more pharmaceutical innovation had larger increases in longevity. It also examined whether there were larger increases in expenditure on classes of drugs that experienced more pharmaceutical innovation, and if more pharmaceutical innovation had larger declines in hospital utilization. The study found that newer drugs contributed to increasing mean age at death in Sweden by 0.60 years during the period 1997–2010, almost a third of the total longevity increase. As well, diseases that experienced more pharmaceutical innovation had smaller increases in hospital utilization. Equally, new drugs were cost-saving: the reduction in annual hospital expenditure induced by pharmaceutical innovation was larger than the induced increase in annual pharmaceutical expenditure.

Frank R. Lichtenberg. Has Medical Innovation Reduced Cancer Mortality? CESifo Economic Studies. Vol. 60, No. 1, 2014, pp. 135-177.

The study analyzed the effects of medical innovation on US cancer mortality rates using observational data from cancer registries for the period 2000-2009. It analyzed the effects of four important types of medical innovation chemotherapy, diagnostic imaging, radiotherapy, and surgical innovation—and cancer incidence rates on cancer mortality rates. During the period studied (2000–2009), the age-adjusted cancer mortality rate declined by 13.8%, while the age-adjusted cancer incidence rate declined by only 4%. The study found that there were three major sources of improvement in the cancer mortality rate, pharmaceutical innovation being the most important one; it is estimated to have reduced the cancer mortality rate by 8.0%. The 3% decline in the cancer incidence rate is estimated to have reduced the cancer mortality rate by just 1.2%. Pharmaceutical and imaging innovation were responsible for more than 85% of the entire decline observed in cancer mortality during the study period.

Frank R. Lichtenberg. Pharmaceutical Innovation and Longevity Growth in 30 Developing and High-Income Countries, 2000-2009. Health Policy and Technology, Vol. 3, No. 1, 2014, pp. 36-58.

This study examined the impact of pharmaceutical innovation on longevity, using longitudinal, country-level data on 30 developing and high-income countries during the period 2000-2009. It controlled for fixed country and year effects, real per capita income, the unemployment rate, mean years of schooling, urbanization rate, real per capita health expenditure (public and private), the DPT immunization rate, HIV prevalence and tuberculosis incidence. Life expectancy at all ages and survival rates above age 25 increased faster in countries with larger increases in drug vintage. The increase in drug vintage was the only variable that was significantly related to all of these measures of longevity growth. Pharmaceutical innovation was estimated to have accounted for almost 75% of the 1.74-year increase in life expectancy at birth in the 30 countries between 2000 and 2009, and for about 33% of the 9.1-year difference in life expectancy at birth between the top and bottom countries.

Frank. R. Lichtenberg, Mehtap & Zafer Çalışkan. The effect of pharmaceutical innovation on longevity, hospitalization and medical expenditure in Turkey, 1999-2010. Health Policy, Vol. 117, No. 3, 2014, pp. 361-373.

The study examined the role played by pharmaceutical innovation in explaining Turkish observed longevity growth (1999-2010). It also evaluated the impact of drug innovation on hospitalization and total health spending. The study found that the absence of any pharmaceutical innovation, mean age at death would have increased by only 0.6 years instead of 3.6 years. It was estimated that the cost per life-year gained from drug innovation to be only $2,776.

Frank R. Lichtenberg. The impact of pharmaceutical innovation on disability days and the use of medical services in the United States, 1997-2010. Journal of Human Capital, Vol. 8, No. 4, 2014, pp. 432-481.

The study assessed the contribution of pharmaceutical innovation in reducing disability days (work loss, school loss) and the use of medical services (hospital admissions) in the United States between 1997-2010. It used aggregate longitudinal data from the Household Component of the Medical Expenditure Panel Survey (MEPS) on about 130 diseases, rather than patient-level data, to determine whether diseases subject to more rapid medical innovation experienced greater declines in disability days. This study accounts for the fact that the rate of pharmaceutical innovation may not be strictly exogenous with respect to the rate of disability decline. To control for this, it used an instrumental variable, namely the potential size of the market for drugs, by medical condition and year. The increase in use of new drugs reduced the mean number of work loss days per employed person (-0.6%) per year (about one-third of the average annual rate of decline of NHIS work loss days) and the mean number of school days lost (0.5%) by more than half of the total. The study also found that reductions in medical services costs ($95 - $125) more than offset increases in newer prescription drug costs ($42).

Te-Fen Lo & Chee-Ruey Hsieh. The adoption of pharmaceutical innovation and its impact on the treatment costs of Alzheimer's disease in Taiwan. Journal of Mental Health Policy and Economics, Vol. 17, No. 3, 2014, pp. 107-117. (not available)

The study examined the impact of new Alzheimer's drugs on health care expenditures in Taiwan between 1997 and 2007. It found that the adoption of pharmaceutical innovation for treating AD is associated with a significant offsetting effect for higher cost patients.

Matea Pavic, Alena M. Pfeil & Thomas D. Szucs. Estimating the potential annual welfare impact of innovative drugs in use in Switzerland. Frontiers in Public Health, Vol. 2, 2014, article 48.

This study estimated the costs and benefits of innovative pharmaceuticals launched from 2000 onward compared to standard treatment in Switzerland in 2010. The study concluded that the entry of newer pharmaceuticals since 2000 generated a potential welfare gain of about CHF 781 million in 2010. Only one of the 31 drugs of the sample produced higher costs per QALY gained versus the standard treatment. The sensitivity analysis showed that results were robust.

Gisela Hostenkamp and Frank R. Lichtenberg. The Impact of Recent Chemotherapy Innovation on the Longevity of Myeloma Patients: US and International Evidence. Social Science & Medicine, Vol. 130, 2015, pp. 162-171.

The study investigated the extent to which the decline in myeloma mortality was caused by innovation in chemotherapy. Data indicated that there were no innovations in chemotherapy for myeloma patients during the period 1977-1997, but that there had been numerous innovations since 1997. The study hypothesized that the sharp discontinuity in the number of available chemotherapy regimens could enable researchers to identify this impact. The study found that the 5-year relative survival rate increased almost three times as rapidly during the period 1997-2005 as it did during the preceding twenty years. It estimated that the increase in the number of chemotherapy regimens preferred by specialists explains 75% of the 8.5%-point increase in the relative survival rate of myeloma patients in the US during 1997-2005. Chemotherapy innovation added about one-life-year per myeloma patient. The study estimated the cost per US life-year gained from post-1997 chemotherapy innovation to be no higher than $46,000.

Darius Lakdawalla et al. Quality-adjusted cost of care: a meaningful way to measure growth in innovation cost versus the value of health gains. Health Affairs, Vol. 34, No. 4, 2015, pp. 555-561.

The study examined the importance of quality of care when assessing the growth in the cost of care. For instance, the cost for treating colorectal cancer increased by $34,493 as a result of the new products entering the market between 1998 and 2005. However, health improved by 0.33115 QALYs, which would be worth $33,115 per person, according to the study' estimates. Thus, the quality-adjusted cost of care increased by only $1,377 during this time period. For the multiple myeloma case study, the study found mitigated results due to approval delays on innovative therapies by the FDA. Quality-adjusted cost of care for established therapies increased by $49,000 per patient between 2004 and 2009. Using evidence from recent clinical trials, the study estimated that the quality adjusted cost of care would have fallen by $82,500 by 2009 if the diffusion of use of bortezomib and lenalidomide in first-line treatment occurred at the same rate as it did in second-line treatment.

Frank R. Lichtenberg & P. A. Laires. The impact of pharmaceutical innovation on longevity in Portugal, 2002-2010. Value in Health, Vol. 18, No. 7, 2015, pp. A536-A537.

This study examined the effects of pharmaceutical innovation on the longevity from all diseases in Portugal (2002– 2010). Diseases for which more drugs were registered during the period 1994-2002 had larger increases in mean age at death during 2002-2010. The increase in mean age at death for high-innovation diseases was 3.1 years, while 1.7 years for low-innovation diseases. About one-third of the total increase in longevity (i.e. 0.8 years) was due to new drugs introduced 1994-2002. Pharmaceutical innovation increased mean age at death by 1.2 months per year. The number of life-years gained in 2010 due to drugs registered during the period 1994-2002 was 84,994.

Frank R. Lichtenberg. Pharmaceutical Innovation, Longevity, and Medical Expenditure in Greece, 1995–2010. International Journal of the Economics of Business, Vol. 22, No. 2, 2015, pp. 277-299.

This study analyzed the impact of pharmaceutical innovation on longevity and medical expenditure in Greece in years 1995–2010. In Greece, between 2000-2007, pharmaceutical innovation increased mean age at death by about 0.9 years, representing approximately 44% of the total increase in longevity observed. Pharmaceutical innovation increased real per-capita pharmaceutical expenditure by $222 during this period, but 62% of this increase was offset by a reduction in hospital expenditure. It concluded that reduced access to newer products would have adverse long-term effects on longevity and other aspects of health.

Frank R. Lichtenberg. The impact of pharmaceutical innovation on premature mortality, cancer mortality, and hospitalization in Slovenia, 1997-2010. Applied Health Economics and Health Policy, Vol. 13, No. 2, 2015, pp. 207-222.

The study tested the hypothesis that pharmaceutical innovation contributed significantly to reducing premature mortality in Slovenia. Longitudinal disease-level data was used to determine whether diseases for which there was a larger increase in the number of new chemical entities (NCEs) previously launched had larger declines in premature mortality. On average, the study revealed that premature mortality from a given disease was reduced by 2.4% 7 years following the introduction of new drug to treat it. The impact of pharmaceutical innovation on premature mortality was larger at higher ages than at lower ages (e.g. child mortality). The study estimated that pharmaceutical innovation explains about two-thirds of the observed decline in premature mortality during the period 2000–2010. In addition, the introduction of NCEs in Slovenia during 1992–2003 reduced the number of premature cancer deaths by 691 in 2008. The NCEs launched in Slovenia during 2003–2009 are estimated to have reduced the number of hospital discharges in 2010 by 7%.

Frank R. Lichtenberg. The impact of pharmaceutical innovation on premature cancer mortality in Canada, 2000-2011. International Journal of Health Economics and Management, Vol. 15, No. 3, 2015, pp. 339-359.

The study examined whether cancer sites that experienced more pharmaceutical innovation had larger declines in their premature mortality rate in Canada during the period 2000-2011, controlling for changes in incidence rates. Results showed that premature mortality before ages 55, 65 and 75 was significantly inversely related to the cumulative number of drugs registered at least 10 years earlier. Had innovative medicines not entered the market during the period 1985–1996, the premature cancer mortality rate would have increased by about 12% during the period 2000–2011. The estimated number of years of potential life lost to cancer before age 75 in 2011 were reduced by about 105,000 due to pharmaceutical innovation during the period 1985–1996. The study estimated the cost per life-year before age 75 gained from previous pharmaceutical innovation to be as low as $2,730 USD.

David H. Howard et al. New anticancer drugs associated with large increases in costs and life expectancy. Health Affairs, Vol. 35, No. 9, 2016, pp. 1581-1587.

This US study estimated the cost effectiveness of new drugs used to treat 4 types of cancer: breast, lung and kidney cancer, along with chronic myeloid leukemia (CML). It used a methodology that allowed isolation of the effect of new drug treatment from that of earlier detection. The study found that life expectancy for patients with breast and lung cancer increased respectively by 13.2 and 3.8 months. This is higher than the 2.0 months (breast) and 0.7 months (lung) increase in life expectancy for those who did not received treatment. Patients with CML experienced the largest gain in life expectancy (22.1 months), which can probably be attributed to the introduction of imatinib in 2001. After adjusting for out-of-pocket spending, the study found that the incremental cost per life-year gained ranged from $114,000 for lung cancer to $145,900 for CML (95% confidence interval).

Frank R. Lichtenberg. The impact of pharmaceutical innovation on premature cancer mortality in Switzerland. European Journal of Health Economics, Vol. 17, 2016, pp. 833-854.

The study analyzed the effect that pharmaceutical innovation has had on premature cancer mortality in Switzerland during the period 1995–2012. It investigated whether the cancer sites that experienced more pharmaceutical innovation had larger declines in premature mortality, controlling for the number of people diagnosed and mean age at diagnosis. The study found that premature cancer mortality before ages 75 and 65 decreases as the number of new medicines approved increases 5, 10, and 15 years before. It was estimated that the number of drugs registered during 1990–2007 was responsible for the gain of over 17,000 life-years observed before age 75 in 2012.

Frank R. Lichtenberg. The impact of pharmaceutical innovation on premature mortality, hospital separations, and cancer survival in Australia. Economic Record, Vol. 93, No. 302, 2017, pp. 353-378.

The study investigated whether the diseases that experienced more pharmaceutical innovation had larger declines in premature mortality in Australia during the period 1998–2011. The analysis revealed that previous pharmaceutical innovation was responsible for as much as 60% of decline in premature mortality (before age 75) observed during 1998–2011. The study also examined how pharmaceutical innovation led to larger or fewer hospital admissions from all diseases during the period 1998–2011. The study estimated that in the absence of new drugs listed on the government formulary (Pharmaceutical Benefits Scheme) during 1986–1999, the number of hospital discharges in 2011 would have been about 13% higher. Lastly, the study analysed the impact of new pharmaceuticals had on survival from all types of cancer during the period 1986–2007, controlling for a series of factors (mean age at diagnosis, the number of patients diagnosed, etc.). It estimated that 40% of increase (from 49.0% to 61.6%) in the 5-year relative survival rate during 1986–2007 could be explained by previous pharmaceutical innovation. The estimated number of reduced life-years lost from all

diseases before ages 75 and 80 because of new drugs stood at 143,639 and 257,602, respectively, in 2011. It concluded that pharmaceutical innovation leads to cost-savings for the PBS, as the reduction in hospital spending attributable to it more than compensate for the greater drug expenditure associated with it.

Frank R. Lichtenberg. The impact of pharmaceutical innovation on cancer mortality in Belgium, 2004-2012. Forum for Health Economics & Policy, Vol. 20, No. 1, 2017.

The study examined whether cancer sites that experienced more pharmaceutical innovation had larger declines in their premature mortality rate in Belgium during the period 2004-2012, controlling for changes in cancer incidence. Premature cancer mortality rates in Belgium before ages 75 and 65 were significantly inversely related to the cumulative number of drugs registered 15–23 years earlier. Drugs registered during the period 1987–1995 reduced the premature cancer mortality rate in 2012 by an estimated 20%. Mean age at death from cancer increased by 1.2 years between 2004 and 2012. Drugs registered during the period 1987–1995 increased mean age at death from cancer in 2012 by about 1.5 years. Drugs registered during 1987–1995 reduced by about 41,200 the number of life-years lost to cancer at all ages in 2012. The estimated cost per-life-year gained in 2012 from these cancer drugs was well below even the lowest estimates from other studies of the value of a life-year saved.

Frank R. Lichtenberg. The impact of cardiovascular drug innovation on the longevity of elderly residents of Switzerland, 2003-2012. Nordic Journal of Health Economics, Vol. 5, No. 1, 2017.

This study examined the impact of cardiovascular drug innovation on the longevity of elderly residents of Switzerland using cross-sectional patient-level data on about 22 thousand patients insured by a major health insurer (CSS) during the period 2003-2011. It controlled for several demographic characteristics and indicators of health status. The results of the analysis showed that cardiovascular drug innovation increased the longevity of elderly cardiovascular drug users by about 5.8% during the period 2003-2012. Cardiovascular drug innovation accounted for almost half of the increase in longevity among elderly residents of Switzerland during 2003-2012, and it increased their longevity by almost 6 months. The analysis revealed that the use of new cardiovascular drugs by elderly residents of Switzerland has been highly cost effective: the cost per life-year gained was estimated at US$9,544.

Tomas J. Philipson et al. The social value of childhood vaccination in the United States. American Journal of Managed Care, Vol. 23, No. 1, 2017, pp. 41-47.

The study used an economic model with parameter values sourced from clinical and observational data, as well as the literature to determine the lifetime social value of guideline-recommended vaccines for children born in the United States in 2009. This model valued the benefits of routine vaccination with quality-adjusted life-years (QALYs) saved, then assigned an economic value by QALY. Producers costs and profits were also estimated. It concluded that by preventing illness and premature deaths, vaccination of children born in the United States in 2009 would generate $184 billion in lifetime social value over and above the costs of the vaccines. Because saving a child's life yields many healthy life-years, the large majority (88%) of vaccination health benefits is due to avoided premature deaths rather than reduced morbidity (12%). The high social value of vaccines has improved population health and provided economic benefit to multiple stakeholders, including patients, health plans, and vaccine manufacturers, whose profits in this cohort amount to approximately 2% ($3.2 billion) of the total social value.

Frank R. Lichtenberg. The impact of pharmaceutical innovation on cancer mortality in Russia, 2001-2011. Journal of Pharmaceutical Health Services Research, forthcoming.

The study observed that in Russia, the overall mortality rate from cancer decreased since 2001. However, the mortality rate declined by at least 23% for four cancer sites (stomach, bladder, lung and leukaemia), but increased for two other cancer sites (prostate and cervix uteri). The study investigated whether cancer sites that experienced more pharmaceutical innovation had larger declines in their premature mortality rate in Russia during the period 2001-2011, controlling for changes in cancer incidence. The age-standardized mortality rate and the number of years of potential life lost before ages 75 and 65 were significantly inversely related to the number of new drugs launched 6 or 7 years earlier. New drugs launched during 1995–2004 reduced the age-standardized cancer mortality rate by an estimated 9.5% between 2001 and 2011, amounting to an average annual rate of about 1%. On average, the launch of one additional drug for a cancer site is estimated to have reduced the number of years of potential life lost before age 75 due to cancer at that site seven years later by about 8,400, and the number of years of potential life lost before age 65 due to cancer at that site seven years later by 4,200. The 14 new drugs launched during 1995–2004 are estimated to have reduced the number of years of potential life lost before age 75 in 2011 by more than 243,000. The estimated cost per life-year gained in 2011 was US$2,170 (about 15% of Russia's per capita GDP).

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