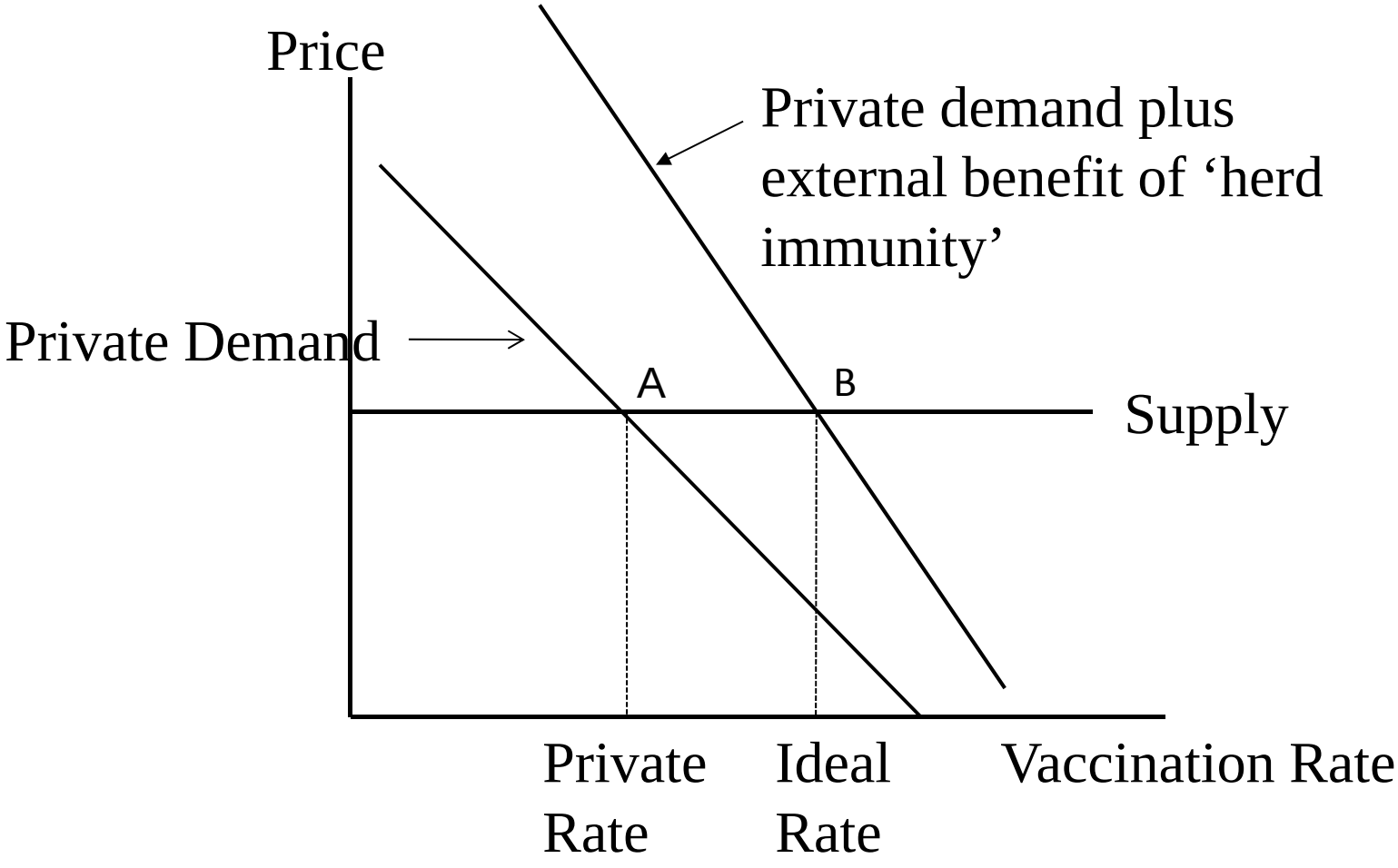
Topic 3: Economics of Vaccines

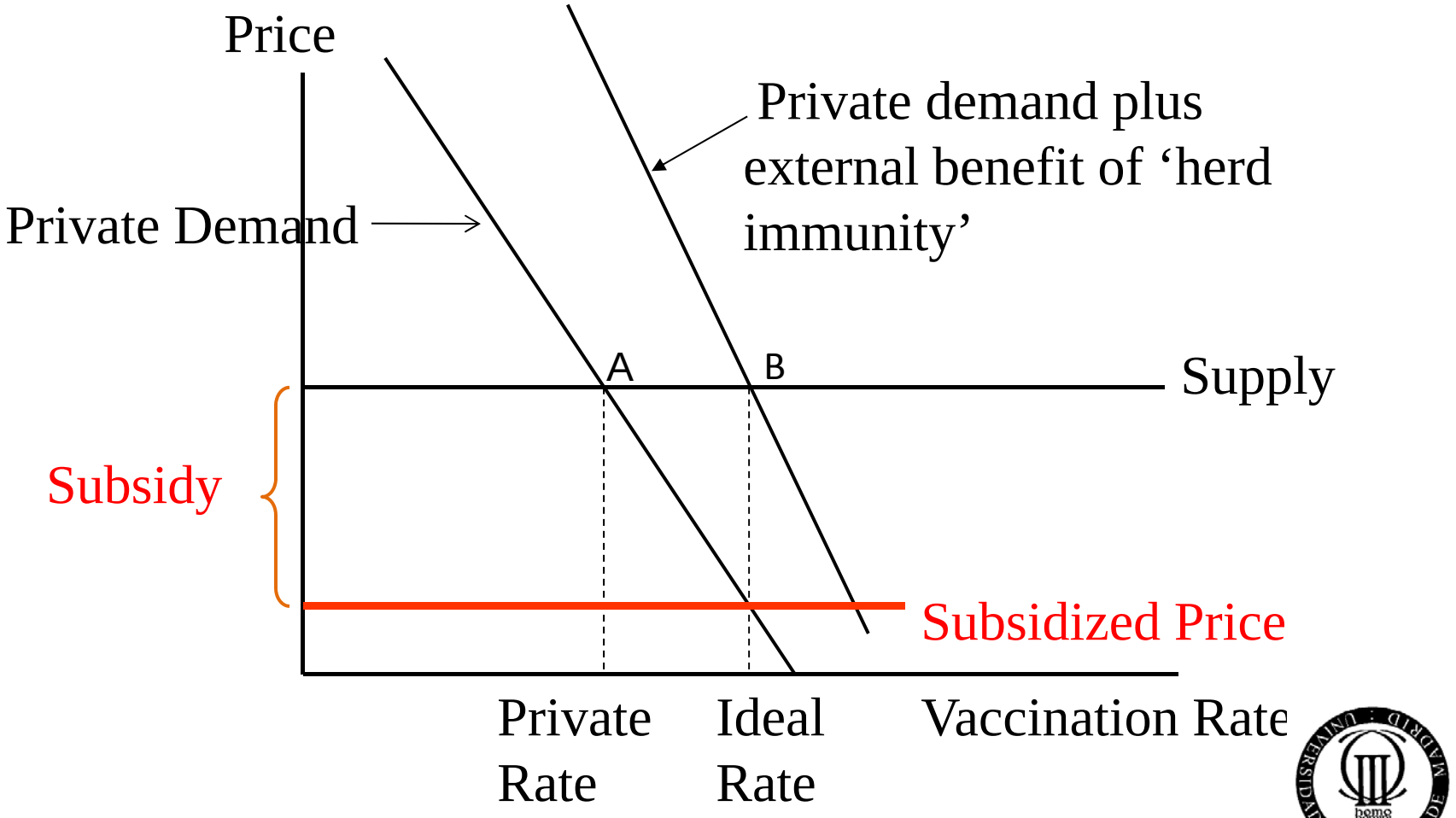
Outline

- Vaccines create positive externalities
  - Subsidize price at the point of use
  - The problem of monopoly pricing
  - Costs and benefits of new vaccines (example of malaria)
  - Role of government in developing new vaccines
  - Ebola vaccine
- Who gets a flu shot?
  - Economic model of decision to get a flu shot
  - Medicare and flu shots
  - Racial differences in vaccination rates
- What is the optimal public policy when some people refuse to be vaccinated?
  - Misinformation about the MMR vaccine

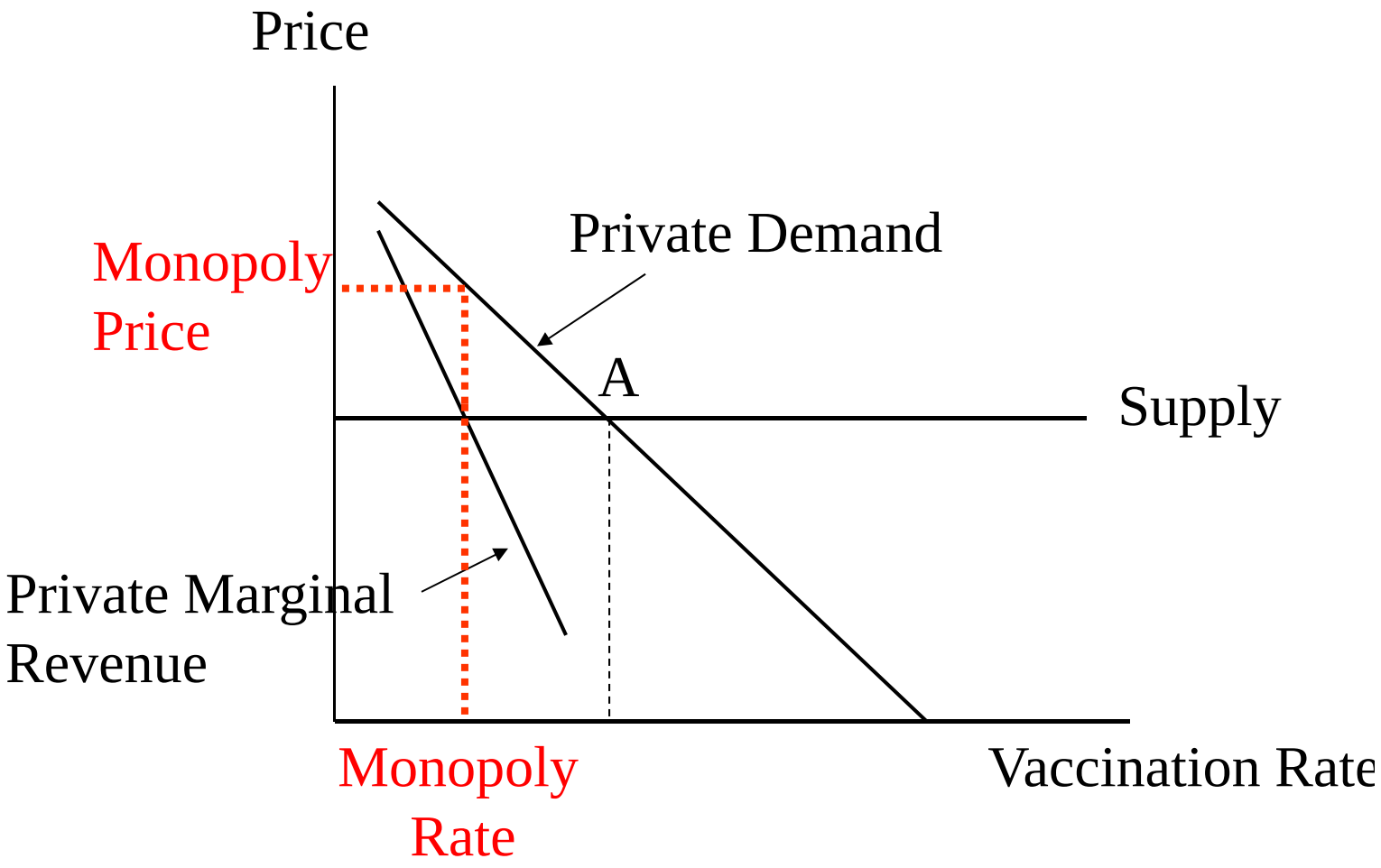
Vaccines Create Positive Externalities



Subsidize Vaccines at Point of Use



Monopoly Adds Another Problem



Government Response

- Monopoly price is too high
- But governments and multi-national agencies are large purchasers of vaccines
- Large purchasers can force the seller to cut the price
- This gets us to point ‘A’ (the private rate)
- We still need the subsidy reach the ideal rate

Benefits of Malaria Vaccine

- An 80% effective, one-shot vaccine against malaria would have large net benefit:
  - Target population = 50 million newborns per year and 10 million women pregnant with first child in low-income countries with high prevalence of malaria
  - Assume program reaches 75% of target children and 50% of target women
  - Delivery cost = $52.2 million per year
  - Saves 17.6 million *disability-adjusted life years* (DALYs) per year @ assumed benefit of $100 per DALY
  - This is a very low benefit for each DALY
  - Net benefit = (17.6 million * $100) – $52.2 million = $1.708 billion per year

M. Kremer, "Creating Markets for New Vaccines, Part I," Innovation Policy and the Economy, 1 (2000), 35-72

What's the Problem?

- Although the delivery cost for malaria vaccine is low ($52.2 million per year), the research and development cost of a malaria vaccine is very high:
  - The average cost of bringing a new drug to market in 2000 was $802 million (Joseph DiMasi, Ronald Hansen, and Henry Grabowski, "The Price of Innovation: New Estimates of Drug Development Costs," *Journal of Health Economics*, 22:2 (2003), 151-185)
  - This does not include the cost of basic research
- Investment in developing vaccines for malaria, TB, and certain strains of HIV has been very low
- Who should pay for the research and development of a malaria vaccine?

‘Push and Pull’ Strategy

- Push: government makes targeted investment in basic research
  - Kremer argues that ‘pushing’ is more effective for financing basic research with no specific vaccine in sight
  - No one knows if/how the research will pay off, so private firms won’t invest enough in basic research
- Pull: government promises to buy the drug if it is developed
  - Provides incentives for drug companies to use basic research to develop new drugs and bring them to market
  - By making the drug available for free (or with modest co-payment), government ensures that the drug will be widely used

How Much Pull?

- Ernst Berndt, et al., "Advanced Purchase Commitments for a Malaria Vaccine: Estimating Costs and Effectiveness," *NBER Working Papers*, 2005, estimate that a guarantee of $15 per 3-shot treatment for the first 200 million treatments ($3 billion) would be enough to pull a malaria vaccine onto the market
- This commitment would be highly cost-effective
- Recent research suggests that this estimate may be too optimistic, but the commitment is still cost-effective

WHO Report on Ebola Vaccine

- "Vaccines will have a significant impact on the future evolution of the epidemic in any scenario, from best-case to worse-case." (*WHO*, October 23, 2014)
- Conversely, the ebola outbreak is unlikely to be contained without deploying vaccines on a massive scale
- Clinical trials should be conducted in West Africa, where populations are more likely to suffer from malnutrition and infections with multiple diseases
- Community engagement and social mobilization are needed to prepare populations to accept clinical trials and vaccination campaigns

Inhaled Ebola Vaccine Could Offer Long-Term Protection

— By IANS | Nov 04, 2014 05:47 pm
New York: A single dose of a breathable, respiratory vaccine could provide long-term protection against the deadly Ebola virus, new research shows. Currently in development, the vaccine was found effective in shielding non-human primates from the virus.
http://freepressjournal.in/inhaled-ebola-vaccine-could-offer-long-term-protection/#sthash.lClV6adk.dpuf

Who Gets a Flu Shot?

- John Mullahy looks at the economic determinants of who gets a flu shot
- Background:
  - 10-50 million cases of flu each year in U.S.
  - 20,000 deaths
  - A major epidemic could cause millions of deaths (1918 flu 'pandemic' killed 50-100 million people worldwide)
  - Flu vaccine is cost-effective for many subpopulations
- Goal: To understand more clearly individuals' propensities to get flu shots

John Mullahy, "It'll Only Hurt a Second: Microeconomic Determinants of Who Gets Flu Shots," Health Economics, 8 (1999), 9-24

1918 Influenza Pandemic

Do you have a relative (probably a great grandmother or great grandfather) who had the flu in 1918?

Do you know why the 1918 pandemic is called the ‘Spanish Flu’?

Mullahy's Economic Model

- Individuals maximize *utilit*y:

  (1) $U = \psi(H, L, Z) - \beta S$

  ψ means 'is a function of'

  H = healthy time

  L = leisure time

  Z = other goods with price of $1 each

  β = 'owie' from vaccination, could also include resistance to vaccination

  S = 1 if you get flu shot, S = 0 if you do not

- Resources are given by the *budget*:

  (2) $w(H - L - tS) = pS + Z$

  w = wage rate

  t = time required to get a flu shot

  p = money cost of a flu shot

- Flu shot *produces* healthy time while exposure (E) reduces healthy time:

  (3) $H = H(S, E)$

Model - 2

- Substitute (3) and (2) into (1) →

  (4) $U = \psi\{H(S,E), L, wH(S,E) - wL - wtS - pS\} - \beta S$

  – Person compares utility with shot vs. utility without shot and picks the choice with higher utility

  – You could use equation (4) to do a personal cost-benefit analysis

- This analysis leads to the following equation for the decision to get a flu shot:

  (5) $S = f(\beta, t, p, E, w)$

- Let's think about the effects of changes in the *exogenous variables*, which are β, t, p, E, and w

Model - 3

- Predicted effects of β (-), t (-), and p (-) are intuitive
- Predicted effect of exposure is not so intuitive
    - When exposure is high the vaccine is more *protective*, i.e. more effective in producing health
    - At low exposure getting vaccinated isn't particularly important
  - Therefore, greater exposure should increase the incentive to be vaccinated

Model - 4

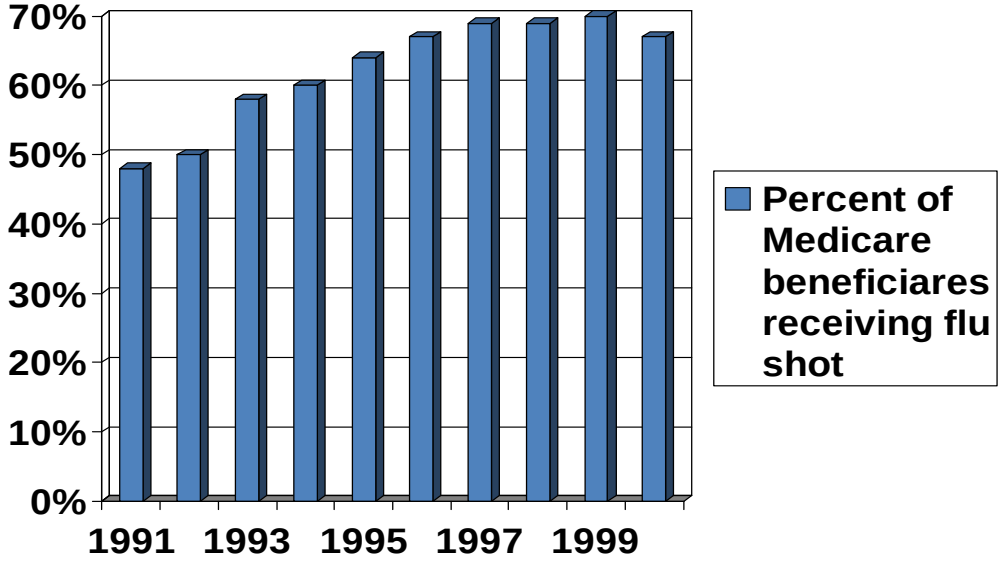
- Predicted effect of higher wage rate is harder
  - Wages enter the utility function through $Z = wH(S,E) – wL – wtS – pS$ (more Z is better)
  - The change in Z if you get a shot is $\Delta Z = wH(1,E) – wH(0,E) – wt – p$
    - This expression could be positive or negative
    - Is it more likely to be positive when w is large?
    - Let's raise w and see: if $H(1,E) – H(0,E) – t > 0$, then an increase in w makes ΔZ larger and increases the incentive to get vaccinated
  - Another way of saying this: if the gain in healthy time is greater than the time it takes to get the shot, then a higher wage rate will increase the probability of getting a flu shot

Selected Results

- Insurance coverage reduces the money price p
- Getting a flu shot is positively associated with insurance coverage
  - Among the non-elderly, having health insurance increases the probability of S by .033 (Table 4)
  - Among the elderly, the insurance effect is much larger but is not precisely estimated
  - Data in next slide suggest that insurance coverage matters a lot for the elderly

Medicare Covers Flu Shots

- Before 1993, Medicare did not cover flu shots
- In May, 1993, Medicare began to offer one free flu shot per year
- Prob(S) jumped



Centers for Medicare and Medicaid Services

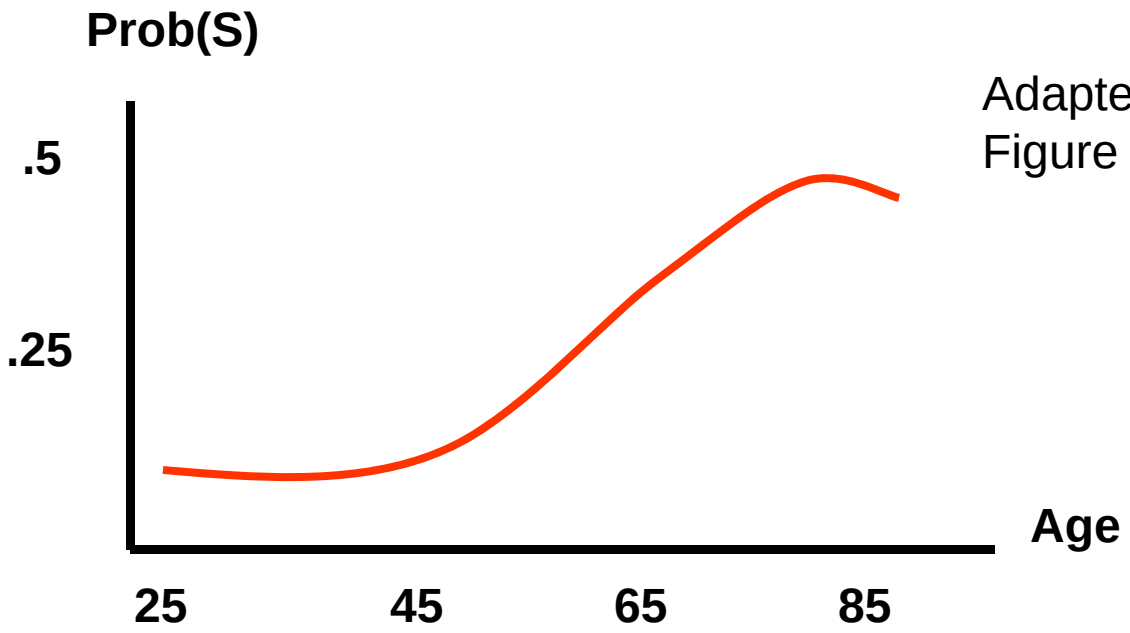
Poor Health and Vaccination

- Poor health (a risk factor) is strongly associated with an increase in the probability of vaccination
- The gradients for non-elderly and elderly are similar

Change in Prob(S) Compared with Excellent Health	**Non-Elderly**	**Elderly**
Very Good	.007	.072
Good	.019	.094
Fair	.055	.106
Poor	.102	.167

Age and Vaccination

- Flat age profile up to about age 45
- After age 45, Prob(S) increases, with the fastest take-up at about age 65
- Probability flattens out & drops a bit for the oldest old – suggests that mobility/access may be issues



Adapted from Mullahy, Figure 2

Wage Rate and Vaccination

- Most of the results suggest that a higher wage rate (or greater labor market participation) reduces the probability of vaccination
  - The estimated coefficient of ln(wage) for the non-aged in Table 5 is -.041
  - Implies that time cost is a serious barrier to getting a flu shot
  - People believe the protective benefit (more healthy time) is not as great as the time required to get a shot
- Walk-in clinics are a private solution to this problem
- Can you suggest some public solutions?

Beneficiary Knowledge

- In 1997, 77.5% of Medicare beneficiaries were aware of the flu shot benefit
- Beneficiary knowledge had a strong positive effect on the probability of getting a flu shot (β = .182)
  - In other words, knowledgeable people were 18.2 percentage points more likely to get a flu shot

Steven Parente, David Salkever and Joan DaVanzo,"The Role of Consumer Knowledge of Insurance Benefits for Preventive Health Care Among the Elderly," Health Economics, 14:1 (2005), 25-38

Racial Differences

- In 1995-96, white Medicare beneficiaries were 50% more likely to report having had a flu shot than were blacks (66.3% versus 44.3%)
- Fewer black than white beneficiaries were aware of the benefit
  - But knowledge explains only 1 percentage point of the difference in vaccination rates
  - Black race effect on knowledge = -.048
  - Multiply by the effect of knowledge on probability of getting a shot: -.048 x .182 = -.0087
- Another possible explanation: patient resistance to vaccination

Parente and Salkever; Paul Hebert, et al., "The Causes of Racial and Ethnic Differences in Influenza Vaccination Rates Among Elderly Medicare Beneficiaries," Health Services Research, 40:2 (2005), 517-537

Resistance to Vaccination

- Hebert et al. measured resistance by agreement with following statements *asked only of non-vaccinated* people:
  - Flu shot causes flu
  - Flu shot has side effects
  - Didn't think it prevents flu
  - Didn't think I was at risk
  - Doctor recommended against it
  - Don't like shots or needles
  - I had one before and don't need it again

Racial Differences - 2

- Whites had lower patient resistance than did blacks:
  - 18.4% agreed with one or more of the resistant attitudes
  - 30.2% of blacks agreed with one or more
  - Differences persisted when adjusted for other factors such as socio-economic status (SES)
- Higher patient resistance among blacks explains 11.8 percentage points (about half) of the racial difference in vaccination rates

Physician's Role in Vaccination

- Some blame incomplete flu vaccination in US on inadequate reimbursement for preventive care
- But vaccination rates in Germany, where family physicians are paid to administer flu shots, are lower than in US
- Points to *physician resistance* as a factor explaining low vaccination rates
- German family physicians who routinely performed recommended geriatric assessments were 12 percentage points more likely to administer flu shots
- Can you think of some public health responses to physician resistance?

Jürgen Maurer, "Who Has a Clue on Preventing the Flu?"
Journal of Health Economics, 28:3 (2009), 704-717

MMR Vaccine and the Autism Scare

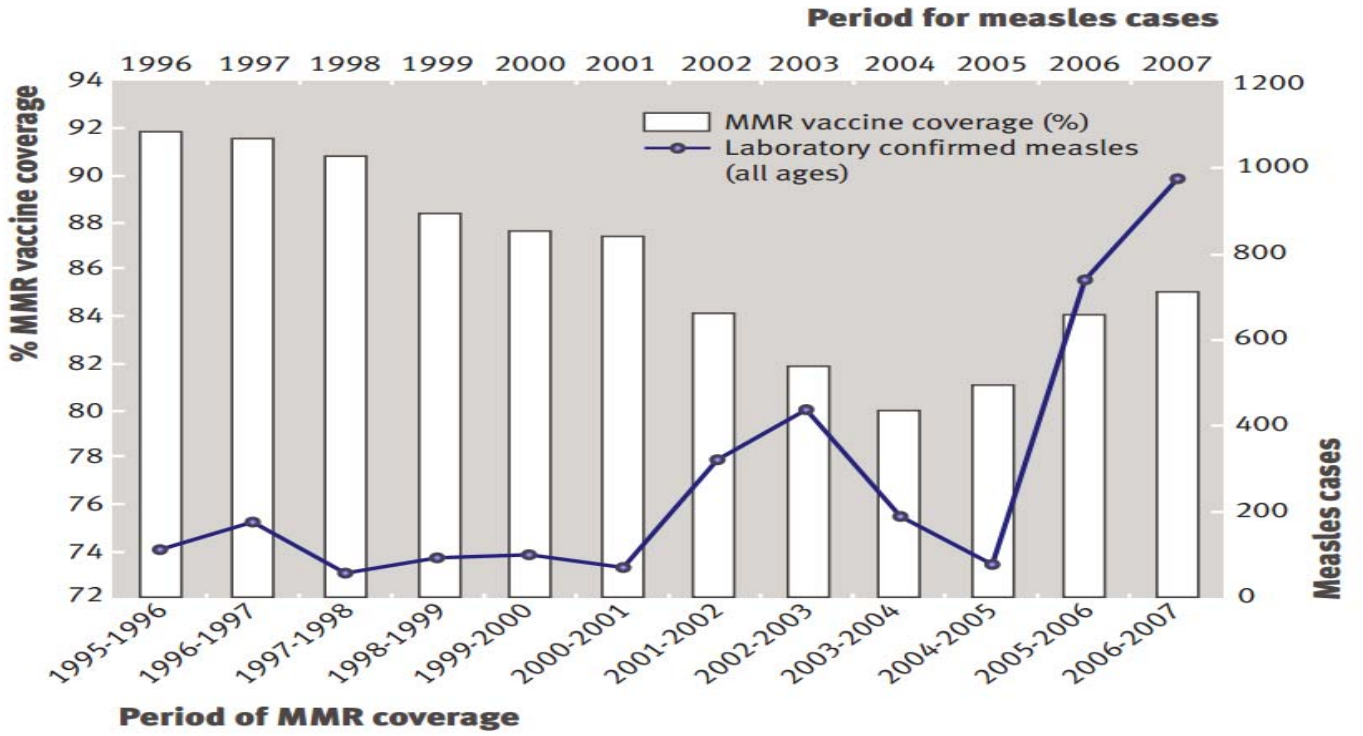
- Measles was a widespread and serious communicable disease until vaccines were developed in the late 1960s
- Measles was eradicated in the U.S.
- 1998 article in the *Lancet*, a respected British medical journal, claimed a link between MMR vaccine and autism
  - Article was criticized for being a small case study with no controls and for relying on parental recall and beliefs
  - Journalist Brian Deer discovered that the lead author had undeclared conflicts of interest and had manipulated the evidence
  - Article declared fraudulent by the *British Medical Journal* in 2011
- But damage was done (next slide)

The Editors, "Wakefield's Article Linking MMR Vaccine and Autism Wa Fraudulent," BMJ, 342 (January 8, 2011), 64-67

Measles Returns to the U.K.

- MMR vaccination rate in UK, already at dangerously low levels, dropped substantially after 1998, while rates for other vaccines remained at about 94%
- Confirmed cases of measles in England and Wales shot up from 56 in 1998 to 971 in 2007
- After disappearing in the US, 118 cases of measles were reported in 1st half of 2011
  - 89% of the reported cases stemmed from importation of the disease
  - Of those cases, 89% occurred in unvaccinated people
  - Risk of disease spreading among unvaccinated US population

Measles Returns to the U.K.



MMR coverage at 24 months in the UK and laboratory confirmed cases of measles for all ages (England and Wales), 1995-2007[3 4]

The Editors, "Improving Uptake of MMR Vaccine," BMJ, 336 (April 5, 2008), 729-730

2014 Measles Outbreak in the U.S.

The Washington Post Print

U.S. measles outbreak sets record for post-elimination era

By Lenny Bernstein Updated: May 29 at 12:04 pm

The ongoing measles outbreak in the United States has reached a record for any year since the disease was eliminated in this country 14 years ago, with 288 cases of the potentially deadly infection in 18 states, the Centers for Disease and Prevention reported Thursday.

The largest measles clusters are in Ohio (138 confirmed cases), California (60) and New York (26), according to the CDC. Almost all — 97 percent — have been brought into the country by travelers, mainly Americans, who contracted the disease abroad. About half of those were people who picked up the disease in the Philippines, where a large measles outbreak has affected more than 20,000 people since October of 2013, causing dozens of deaths.

In this country, the biggest outbreak is centered in the Amish community in Ohio, where many of the residents are unvaccinated, the CDC reported.

Attitudes Toward Vaccination

- In 2002, 22% of mothers in the UK considered MMR vaccine a greater risk than the disease it prevents
- Fortunately, this rate dropped to 14% in 2006, but it is still stubbornly high
- In the US, 2/3 of those who do not get vaccinated cite religious or philosophical objections
- A 2006 study in *BMJ* distinguished two groups of 'rejecters' – those who might support vaccination in some situations, and those who follow alternative concepts of health and refuse all vaccines
  - Article recommended focusing on the first group
  - Pilot work found that a decision aid for MMR could influence attitudes and knowledge

Cate Wallace, Julie Leask, and Lyndal Trevena, "Effects of a Web Based Decision Aid on Parental Attitudes to MMR Vaccination: A Before and After Study," BMJ, 332 (January 19, 2006), 146-149

Limits of the Economic Approach

- Given that some people will not get vaccinated under any conditions, it is critical to achieve complete or nearly complete vaccination rates among other people
- The economic approach suggests that MMR vaccine should be free on demand
- But the economic approach needs to be supplemented with other strategies:
  - Doctors and nurses should be encouraged to recommend and administer MMR vaccine
  - Patient education is important
  - So is outreach to moderate 'rejecter' groups