PACER
A HOMELAND SECURITY CENTER OF EXCELLENCE

**The National Center for the Study of Preparedness and Catastrophic Event Response**

CREATE
HOMELAND SECURITY CENTER

# *Resilience in the Face of Pandemics*

4th Annual DHS University Network Summit

# Reslience in the Face of Pandemics

- Introduction
- Lynn R. Goldman, MD, MPH
- PI, PACER

# What is Resilience?

- **Systems approach: resiliency is reduced probability of system failure, reduced consequences due to failure, and reduced time to system restoration of communities**
- **Achieving resiliency: improved engineering and management tools for critical infrastructure systems (water supply,electric power, and hospitals) and emergency management functions (including management of pandemics)**

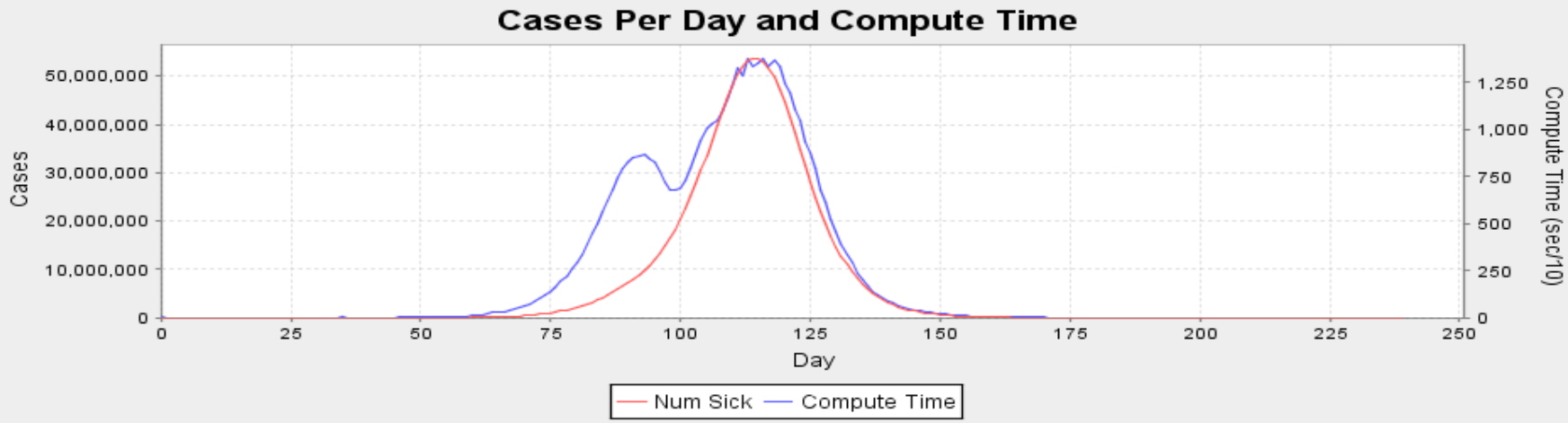
# The Base Case

**Run Summary:**

**Total Cases: 243411248**

**Number Days: 240**

**Core Run Data:**




- 243.4 Million Cases (Peak ~50 Million)
- ~300 Days

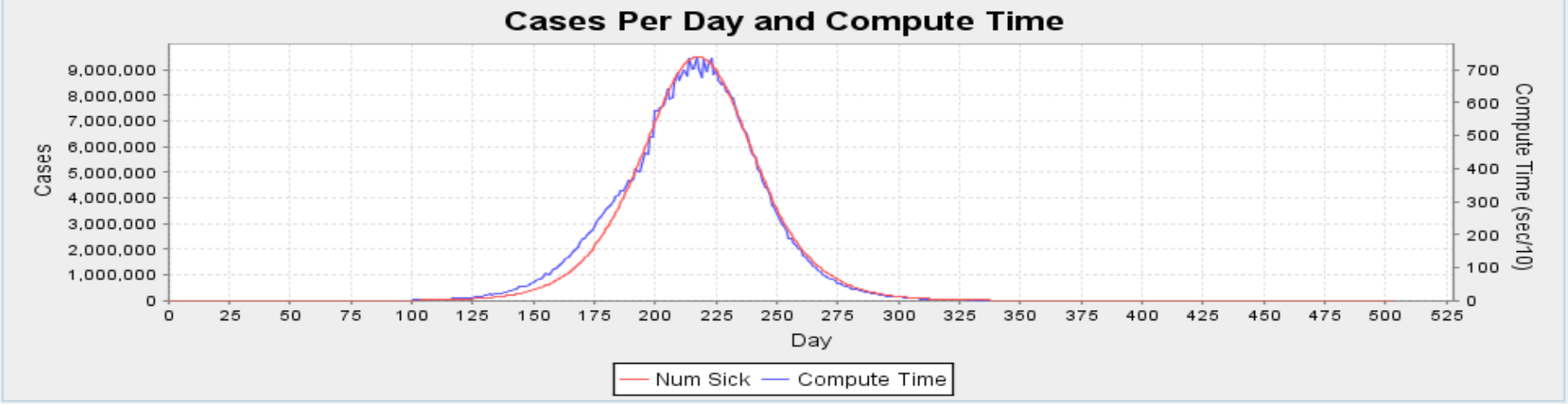
# 30% Vaccination

**Run Summary:**

**Total Cases: 98357828**

**Number Days: 504**

**Core Run Data:**




- 98.3 Million Cases (Peak ~9 Million)
- ~300 Days
- 90 Million vaccines given, but 145 Million fewer cases

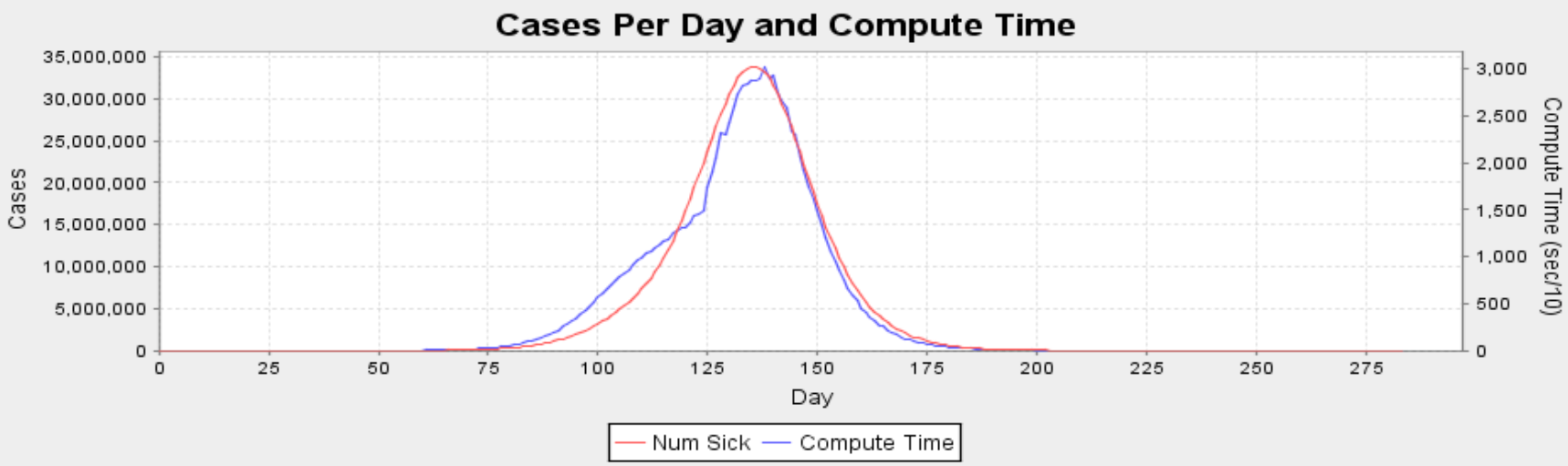
# School Closures

**Run Summary:**

**Total Cases: 200228340**

**Number Days: 284**

**Core Run Data:**




- 200.2 Million Cases (Peak ~32 Million)
- 175 Days

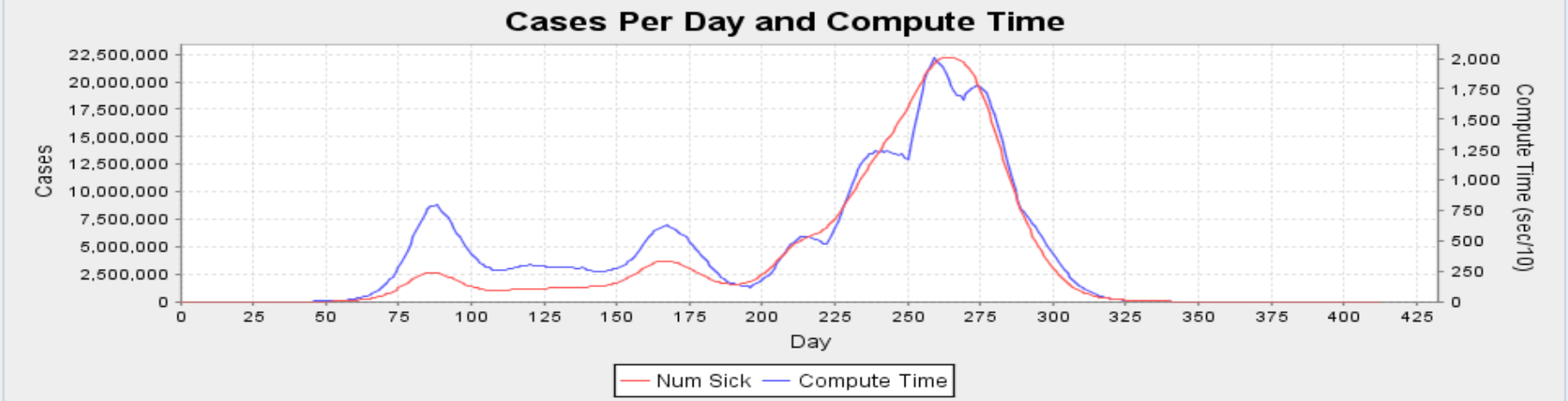
# Travel Restriction

**Run Summary:**

**Total Cases: 249169957**

**Number Days: 413**

**Core Run Data:**




- 249.1 Million Cases (Peak ~21 Million)
- ~320 Days
- Doesn’t reduce attack rate, but buys time

# Pandemic Resilience

- Primary goals are to reduce:
  - Numbers of individuals infected
  - Numbers of individuals infected who die or are permanently injured
  - Numbers of individuals who are infected at any one time
- Secondary goals are to societal impacts that also cause illness, death disability:
  - School absences
  - Work absenteeism especially from critical infrastructure (e.g., medical, food, water, utilities)
  - Negative economic consequences

# Theme of this Session

- Through research we can develop improved management and decision processes and protocols to:
  - Reduce morbidity and mortality
  - Better manage surge capacity
  - Prevent secondary impacts of pandemics due to school closings and worker absenteeism
  - Understand economic impacts of decisions

International Herald Tribune
*Friday, October 7, 2005*

**Agenda:**

- **Costs of School Closures**

**Joshua M. Epstein, PhD**

- **Mitigating Hospital Worker Absenteeism During a Pandemic**

**Andrew Garrett MD MPH**

- **Effects on the U.S. Economy of an H1N1 Epidemic: Analysis with the USAGE Model**

**Adam Rose, PhD**

Center for
Social and Economic Dynamics
at BROOKINGS

# Costs of School Closure

Howard Lempel
Ross A. Hammond
Joshua M. Epstein

Economic Studies Program, The Brookings Institution

# Outline

- Why Close Schools?
- Direct Economic Cost
  - ❑ Decreased GDP through absenteeism, workers staying home to care for school aged children (<16)
- Disparate Impact on Households' Finances
  - ❑ One-earner households particularly at risk
- Disruption of Education
  - ❑ Lost classroom time impedes learning, especially for low-income students
- Impact on Health Care System
  - ❑ Absenteeism from Health Care Work Force specifically
- Implications for Policy and Future Research

# Why Close Schools?

- Closing schools can reduce social contact among children, who are especially likely to catch and spread the flu virus.
- Review by Cauchemez, et. al. found that closing schools could modestly reduce total cases and greatly reduce peak attack rates.[1]
- High peak attack rates could overwhelm health care system.

1 Cauchemez S, Ferguson, NM, Wachtel C, Tegnell A, Saour G, Duncan B, Nicoll A: **Closure of Schools During an Influenza Pandemic.** *Lancet Infect Dis* 2009, 8: 473-481.

# But closing schools also has costs…

# Costs Associated with School Closure: Direct Economic Costs

- If schools close, parents must find way to look after children
- Some households will have adults who can care for children without missing work
- In other households, adults will need to miss work
- Those missed work hours are costly to the economy!

# Calculating Economic Costs:
## Selected Considerations

- How much worker absenteeism does closure produce?
  - ❑Are all household adults fully employed?
  - ❑If so, do any have informal child care?
  - ❑If not, can any employed adults work from home?
  - ❑If [Y, N, N] an absentee
- How does that absenteeism from the labor force affect GDP?
  - ❑Who stays home (Occupation, Gender, Age)
  - ❑Can coworkers pick up slack from absentees?
  - ❑Are absent workers able to make up missed work?
  - ❑How do we value their lost production?

# How large are the potential direct economic costs of closing schools and formal daycare?

## Economic Cost of Absenteeism Due to School Closure in the U.S. (Three Scenarios[1])

[1] See Table 1 for description of scenarios.

# Economic Costs for Various Closure Durations

Economic Costs of Absenteeism Due to School Closure in the United States
(Billions of 2008 US dollars and Percent of 2008 GDP)

| Closure Length | | Low Cost Estimate[1] | Base Estimate[2] | High Cost Estimate[3] |
|---|---|---|---|---|
| **2 weeks** | | **$5.2 (<0.1%)** | **$21.3 (0.1%)** | **$23.6 (0.2%)** |
| **4 weeks** | | **$10.6 (0.1%)** | **$42.6 (0.3%)** | **$47.1 (0.3%)** |
| **6 weeks** | | **$15.6 (0.1%)** | **$ 63.9 (0.4%)** | **$70.7 (0.5%)** |
| **12 weeks** | | **$31.3 (0.2%)** | **$127.8 (0.9%)** | **$141.3 (1.0%)** |

Sources: 2007 and 2008 CPS Outgoing Rotation Groups; 2008 CPS March Supplement; Child Care Module of the 2004 SIPP; Sadique et. al.; Harvard School of Public Health Project on the Public and Biological Security's *Pandemic Influenza Survey.*

[1] Allows for use of informal care and work-from-home and assumes the elasticity of output with respect to hours worked is 0.8. If a male and female are equally closely related to a child, the female misses work.

[2] Assumes that an adult must miss work in each household with at least one child and the elasticity of output with respect to hours worked is 1. If a male and female are equally closely related to a child, the female misses work.

[3] Assumes that an adult must miss work in each household with at least one child and the elasticity of output with respect to hours worked is 1. Assumes that households randomly choose whether males or females care for children.

# Cost Per Student

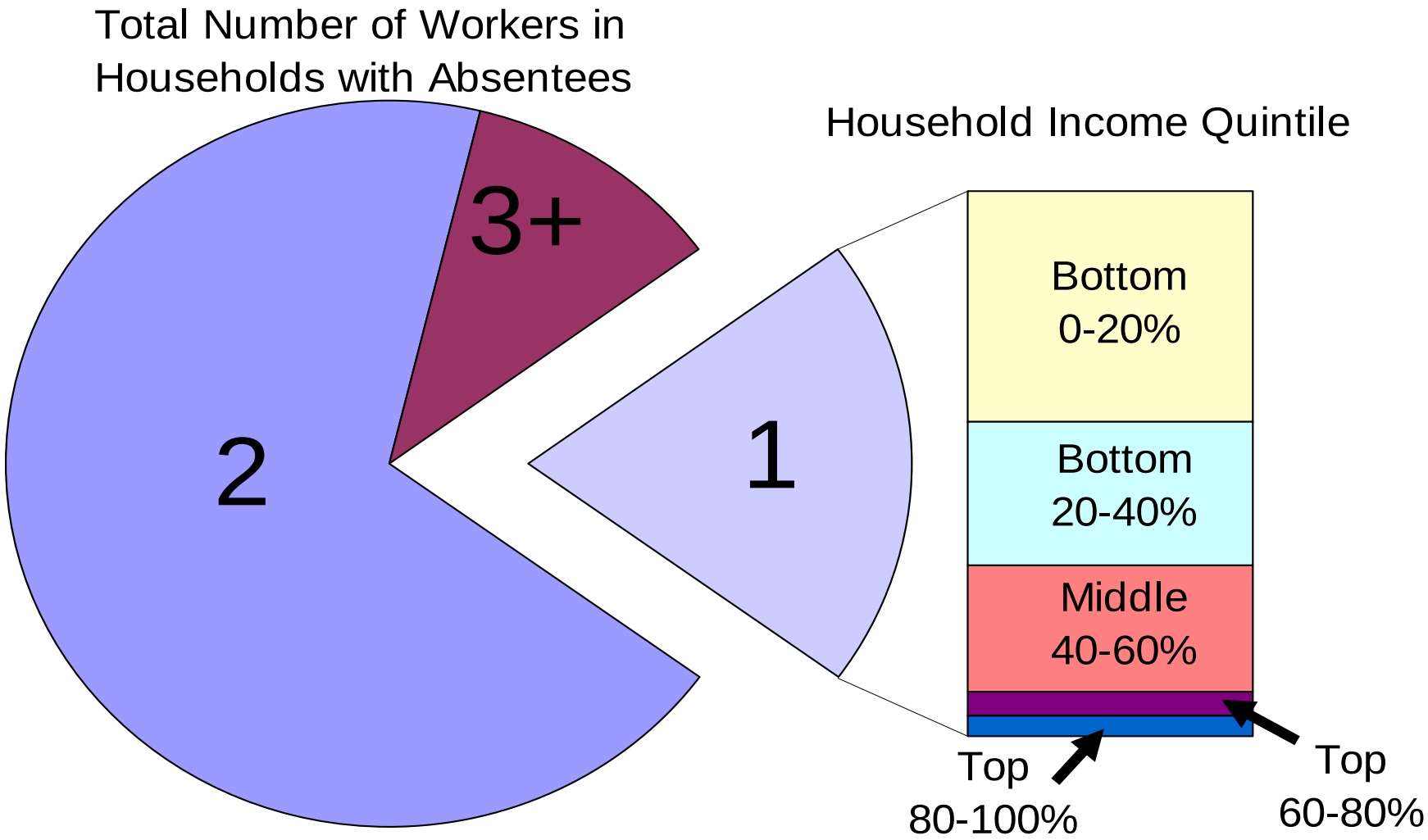
- Cost per student allows any regional breakdown of interest
- Cost per student per week of closure is
  - ❑$ 35 Low
  - ❑$142 Baseline
  - ❑$ 157 High

❑ Ignores regional heterogeneities (future research)

- Estimated cost of 4-week school closure for:
  - Los Angeles County: $1.5 billion
  - New York City: $1.1 billion
  - Washington, D.C.: $65 million

# Economic Impact of School Closures Unevenly Distributed at Household Level

# Households with Just One Worker Are Most Vulnerable to School Closure




20% of projected absentees live in households with no other workers and are at risk of having no earned income if they miss work to provide childcare. These absentees predominantly live in low- and middle-income households.

# School Closure Also Disrupts Education

# Impact of School Closure on Students

- Evidence from staff compensation
  - Lost learning costs $6.1 billion per week
- Evidence from summer learning loss[1]
  - On average, students lose about one month of learning over summer break.

[1] Cooper H, Nye B, Charlton K, Lindsay J, Greathouse S: **The effects of summer vacation on achievement test scores: A narrative and meta-analytic review.** *Rev Ed Research* 1996, 66: 227-268.

# Some absent workers will be from Health Care Workforce (HCW)

# Health Care Impact of School Closure

- How large is absenteeism level among HCW?
- For delivery of services, correct measure is work hours (not percent of work force)
- Estimate of percent work hours lost among key health care personnel
  - ❑6% Low
  - ❑19% High
  - ❑Excludes absent due to illness or fear

# Potential Impact of HCW Absenteeism

- Does this loss in work hours degrade mitigation?
  - ❑Vaccine delivery
  - ❑Treatment
- If so, should special arrangements be made for school-age children of HCWs?
- Might do this at low cost, by using teachers.

# Summary: Costs of School Closure

- Surprisingly high direct economic costs
  - 4 weeks = $47 B.
- Interruption in education
- Substantial absenteeism in the HCW force, and associated degradations in vaccine delivery and other mitigation efforts.
- Important: If the epidemic is severe, the benefits of closing schools may outweigh these costs.

Columbia University
MAILMAN SCHOOL
OF PUBLIC HEALTH

# Mitigating Hospital Worker Absenteeism During a Pandemic

Andrew Garrett MD MPH

# Clarification and Disclaimer

- Presentation contains information developed and collected while the presenter was affiliated with Columbia University Mailman School of Public Health, at the National Center for Disaster Preparedness

- Information in this presentation does not represent the opinions of the U.S. Department of Health and Human Services or the federal government.

# Why is this issue important?

- In the post-9/11 era there has been a recognized need to develop emergency plans
- Making these plans purposeful is a challenge
  - Good plans need to reflect the reality of work conditions during a disaster
- Most existing plans from the private and local to the federal level, do not acknowledge the challenging operational issue of what percentage of staffers will likely report for duty during a disaster

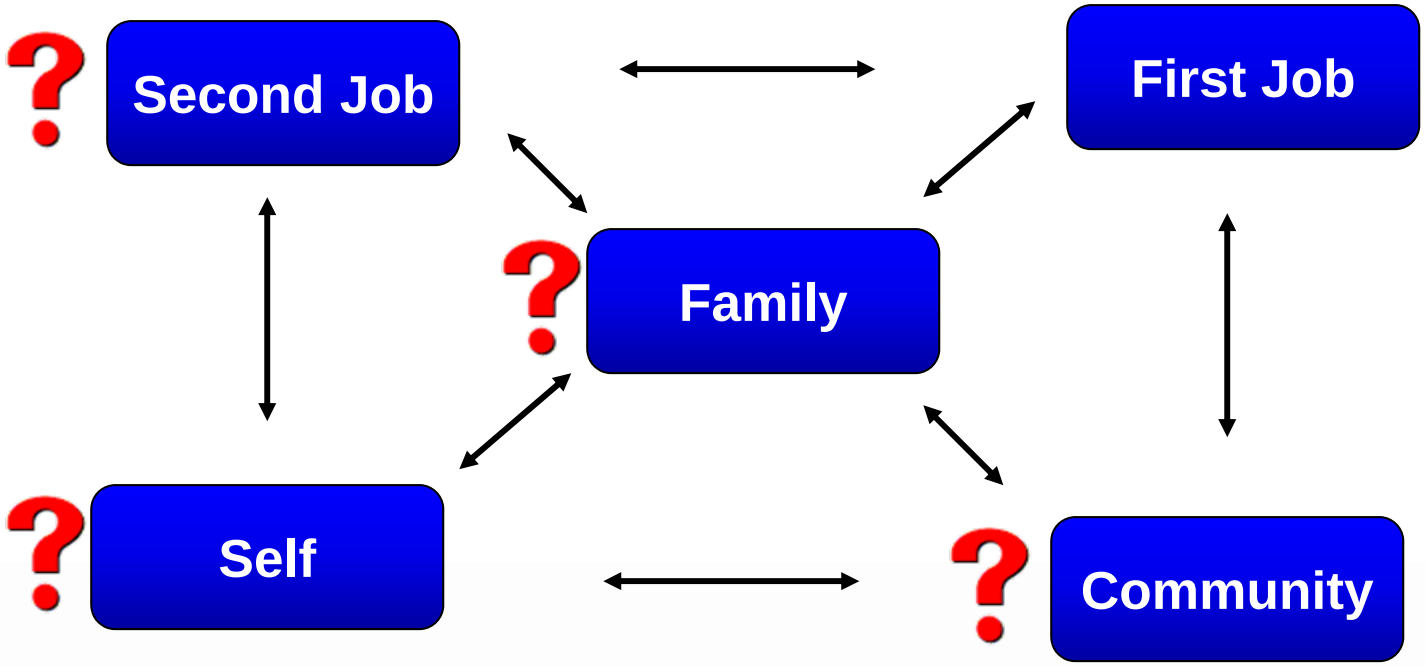
# How have we traditionally planned for disasters?

- *Planning for historic disasters, yet forgetting history*
  - Example: 2005 and Hurricanes Katrina and Rita
    - We had set an agenda in preparedness for terrorism
    - Pandemic preparedness became the “rebound relationship”

- The focus became developing a product to meet a mandate
  - Assumptions were made…
    - a ramped-up *business-as-usual* stance
    - If we need employees they will be there
  - However… our business tends to not take planning seriously
    - We infrequently drill our plans
    - When we do, we rarely *challenge* our plans
    - Why?  Preparedness is hard to sell!

# What assumptions exists around disaster workforce issues?

- "If I need them they will show up"
- Reality: Competing interests of personnel
- Usually not an issue during normal operations



# What background is there on disaster workforce issues?

- Emerging evidence is informing some of our assumptions
  - Information on *ability and willingness to work* is emerging
  - Collectively termed "absenteeism"
    - Health care workers
    - Public Health
    - Prehospital Personnel
- All important players in the Health and Public Health critical infrastructure sector
- A concerning theme has emerged around absenteeism during certain disasters such as pandemics:
  - In some studies *50% or more* answered other than "yes" to the question of *will you report for duty*
  - In one study, only 33% of organizations reported that they felt "most [employees] will come to work" in a pandemic

# Developing a research question

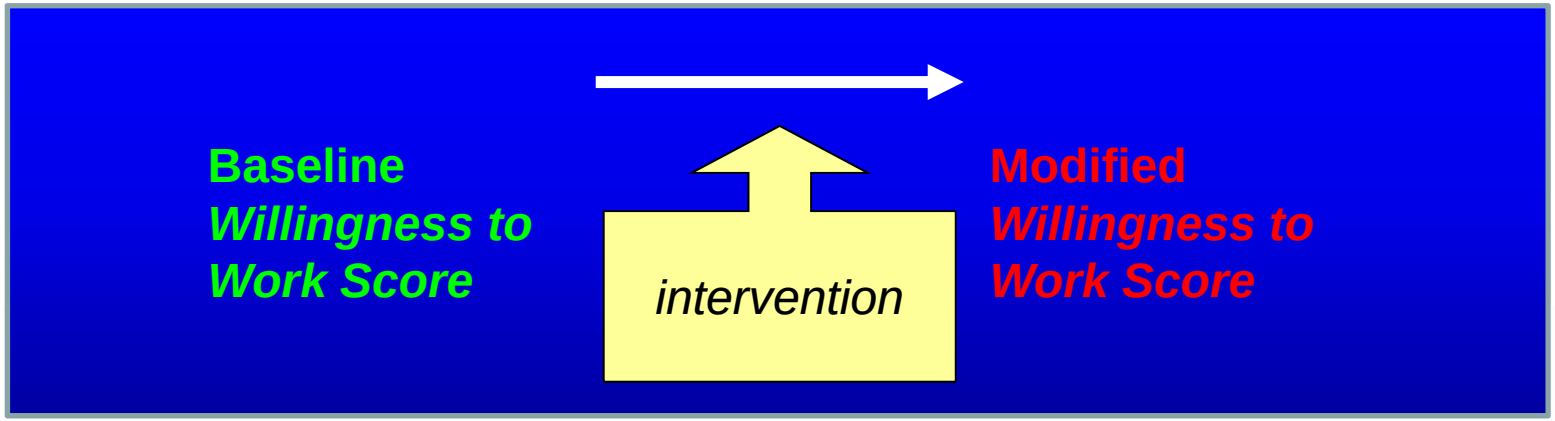
- Issues that decrease ability and/or willingness are termed “barriers”
- Identifying barriers is an important first step
  - Elucidating themes, clusters, patterns, etc. that may be amenable to *mitigation*

- This is an question of gauging public opinion
  - Surveys
  - Focus Groups
  - Key Informant Interviews

# Overview of the project

- Variables explored
  - Identifying Barriers
    - These were chosen from a list
      - Developed from focus groups
  - Uptake of interventions to mitigate absenteeism

- Simple methodology of pre-post scoring under simulated "moderate" pandemic conditions:



# Overview of the project

- 2009 survey of all hospital workers at five facilities
  - 2 university hospitals, 1 children's hospital, 1 mental health care facility, 1 community hospital
  - Sample frame ~17,000

# Candidate interventions

- Depended upon barrier chosen in survey
  - Preferential access to Tamiflu® for employee alone
  - Preferential access to Tamiflu® for immediate family
  - Take-home PPE for employee alone and family
  - Comp time
  - Bonus pay
  - Liability coverage
  - Dependent (or pet) care provided
  - Dependent (or pet) care reimbursement
  - Transportation facilitated
  - Boarding options offered

# Findings- Demographics

- Responses: 2864 (roughly 20% response rate)
- Position:
  - Practitioner 20%, Nursing 29%, Admin 21%, Clinical Support 12%, Non-clinical Support 19%
- 75% Female
- Shifts:
  - 74% Day, 10% Overnight, 11% Variable
  - 91% Full-time
- Child in Home < 18 yrs old: 36%
- “Dependent” Spouse or Partner in Home: 37%

# Findings- Barriers

- Major themes around barriers emerged:
  - Safety concerns for the family or self were the top barriers, collectively accounting for 43% of the top barriers reported
  - Care responsibilities for adults and children ranked highly
    - Two of the top six barriers cited, representing 23%
  - As did transportation issues

- 76% of respondents cited one of these themes of barriers

# Rank of Top Barriers Reported

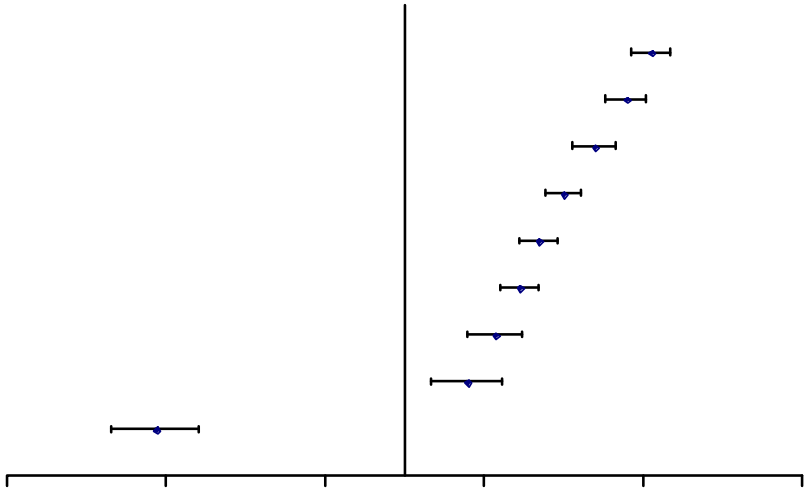
| Rank | Barrier | Frequency | Percent |
|---|---|---|---|
| 1 | Family Safety | 701 | 25.03 |
| 2 | Personal Safety | 505 | 18.03 |
| 3 | Child Care | 453 | 16.17 |
| 4 | None Identified | 359 | 12.82 |
| 5 | Transportation | 301 | 10.75 |
| 6 | Adult Care | 181 | 6.46 |
| 7 | Lack Training | 130 | 4.64 |
| 8 | Other Issues | 58 | 2.07 |
| 9 | Pet Care | 34 | 1.21 |
| 10 | Legal | 11 | 0.39 |

# Findings- Uptake of Interventions

- WTWS were significantly increased for most of the interventions
- Themes:
  - Interventions that incorporated the employees' families were the best received
  - Money and vacation time is not the top priority for employees during a pandemic
  - Employees prefer to maintain their choice in interventions that affected them, such as with babysitters and elder care
  - Workers liked tangible interventions- such as access to medication or PPE

# Uptake of Interventions to Mitigate Absenteeism (pooled across barriers)

| ervention* | *n* | Mean | 95% Confidence Interval | |
|---|---|---|---|---|
| Tamiflu/family** | 1,799 | 15.44 | 14.18 | 16.70 |
| PPE/family | 1,775 | 13.88 | 12.61 | 15.16 |
| PPE/employee | 2,085 | 11.91 | 10.50 | 13.32 |
| amiflu/employee | 2,101 | 9.92 | 8.82 | 11.01 |
| Bonus Pay | 2,217 | 8.40 | 7.20 | 9.60 |
| Comp Time | 2,213 | 7.21 | 5.99 | 8.42 |
| oard at Hospital | 1,468 | 5.65 | 3.95 | 7.35 |
| tter Reimbursed | 620 | 3.88 | 1.68 | 6.08 |
| Sitter Provided | 660 | -15.70 | -18.44 | -12.97 |



Change
In
WTWS
**(X=75.6)**

# Safety is a worker's top priority- with a focus on their family

- Other studies that explored barriers without looking at mitigation have consistently revealed:
  - Concern for family safety is cited most frequently (7 additional studies)
  - Support from family likely affects employee's decision to work
- The role of the employee's immediate family is rarely taken into consideration by emergency planners
  - Potential untilled opportunity
    - Military has begun this approach

# Care obligations at home are another important barrier

- The need to provide child care at home was the third most frequently cited barrier
- Significant issue considering the makeup of the health care workforce
- Different interventions to mitigate this had highly variable results:
  - Example: reimbursing for sitter/care provider chosen by employee (approx **+5** WTWS) vs. being offered a babysitter chosen by the hospital or government (approx **-15** WTWS)
- The need to care for an adult at home was the fifth most frequently cited barrier
- Pets?

# An early strategy to maximize workforce

- Appreciate that preparedness exists in microclimates
  - Each may have distinct barriers
- Despite this, there are consistent themes
  - Remember that family issues and safety concerns are consistently significant for workers
- Acknowledge that employees likely have divided responsibilities besides your worksite
- Start talking about the problem by *listening*
  - Our focus groups revealed tremendous information
- Use evidence to guide the process where possible

CREATE
HOMELAND SECURITY CENTER

# Effects on the U.S. Economy of an H1N1 Epidemic: Analysis with the USAGE Model


Peter Dixon (CoPS, Monash)

Bumsoo Lee (URP, Illinois)

Todd Muehlenbeck (CREATE, USC)

Maureen Rimmer (CoPS, Monash)

Adam Rose (CREATE, USC)

George Verikios (CoPS, Monash)

# Base Case

- Basic impacts
  - Absence from work due to illness
  - Absence from work due to caring for others
  - Death
- Voluntary mitigation
  - reduced travel & tourism
  - reduced attendance at public gatherings
- Remediation
  - hospitalization
  - medication

# Forced Mitigation Measures

- Shut-down of border
  - Migration
  - Travel and tourism
  - Trade
- School closure
- Ban on public gatherings
- Quarantine

# Resilience

- Labor productivity improvement (picking up the slack)
- Inventories of vaccines
- Excess capacity of hospitals
- Market resilience (automatic stabilizers & bounce-back)
  - wage rate adjustments
  - exchange rate adjustment
  - investment adjustment

# USAGE Model

- Computable general equilibrium (CGE) model: multi-market model of consumer and producer responses to price signals, subject to constraints on resource availabilities.
- Model structure
  - 500 industries
  - 700 occupations
- Quarterly time periods
- Dynamics
  - capital accumulation
  - liability accumulation
  - lagged adjustment process

# USAGE Model Applications

- International Trade Commission
  - import restraints study
  - free trade agreements
- Department of Commerce
  - environmental regulations
  - energy security
  - illegal immigration
  - stimulus package
  - tax policy
- Department of Homeland Security
  - illegal immigration
  - H1N1 epidemic (CREATE)
  - port closure (CREATE)
- Department of Agriculture
  - guest-worker program
  - food versus fuel
- Department of Treasury
  - Waxman-Markey climate bill

# USAGE Modifications for Epidemic Analysis:

- Quarterly rather than annual time periods
- Allowance for excess capacity
- Modification of investment responses

# H1N1 Epidemic Specification

- 90 million people infected in 2010.Q1 and 2010.Q2

- 59.8 million experience symptoms

  29.91 million, pharmaceuticals only, $3/person
  29.62 million, doctor & meds, $293/
  0.25 million, hospital & recover, $18,298/
  0.02 million, hospital & die, $46,120/

- Total additional medical expenditures = $14.15b

# Economic Impact Effects

S1. *inbound and outbound international tourism & business travel*

-> 34% &17% decrease, respectively

S2. *sick leave & school closure* (parents withdraw from L force)

-> 0.41% loss of productivity

S2'. *permanent reduction in L supply due to deaths*

-> 0.0053% loss of productivity

S3. *demand for hospital and other medical services*

-> 2.41% increase

S4. *average propensity to consume*

-> 0.55% reduction associated with a 10% reduction in expenditure on leisure involving public gatherings

# Loss of Work Time: 2010.Q1 & Q2

- worker sickness: 42.2 million days
- caring for school children: 31.8 million days
- Total lost work days: 74.0 million days
- Loss of productivity: 0.4 per cent (74m of 18b)

# Simulation Results on Employment

**Impacts during Peak Quarter**

- Base Case

| | |
|---|---|
| L productivity | -0.15% |
| Tourism | -1.03% |
| Pub gatherings | -0.80% |
| Med treatment | -0.08% |

**Impacts for Entire Period**

- Base Case (2.75 yrs)

| | |
|---|---|
| L productivity | -0.03% |
| Tourism | -0.13% |
| Pub gatherings | -0.11% |
| Med treatment | +0.002% |

- Border shutdown (1 yr)

| | |
|---|---|
| Migration | -0.20% |
| Trade & Tourism | -6.20% |

- School closures (4 weeks)

> -0.004%

# Resilience Potential

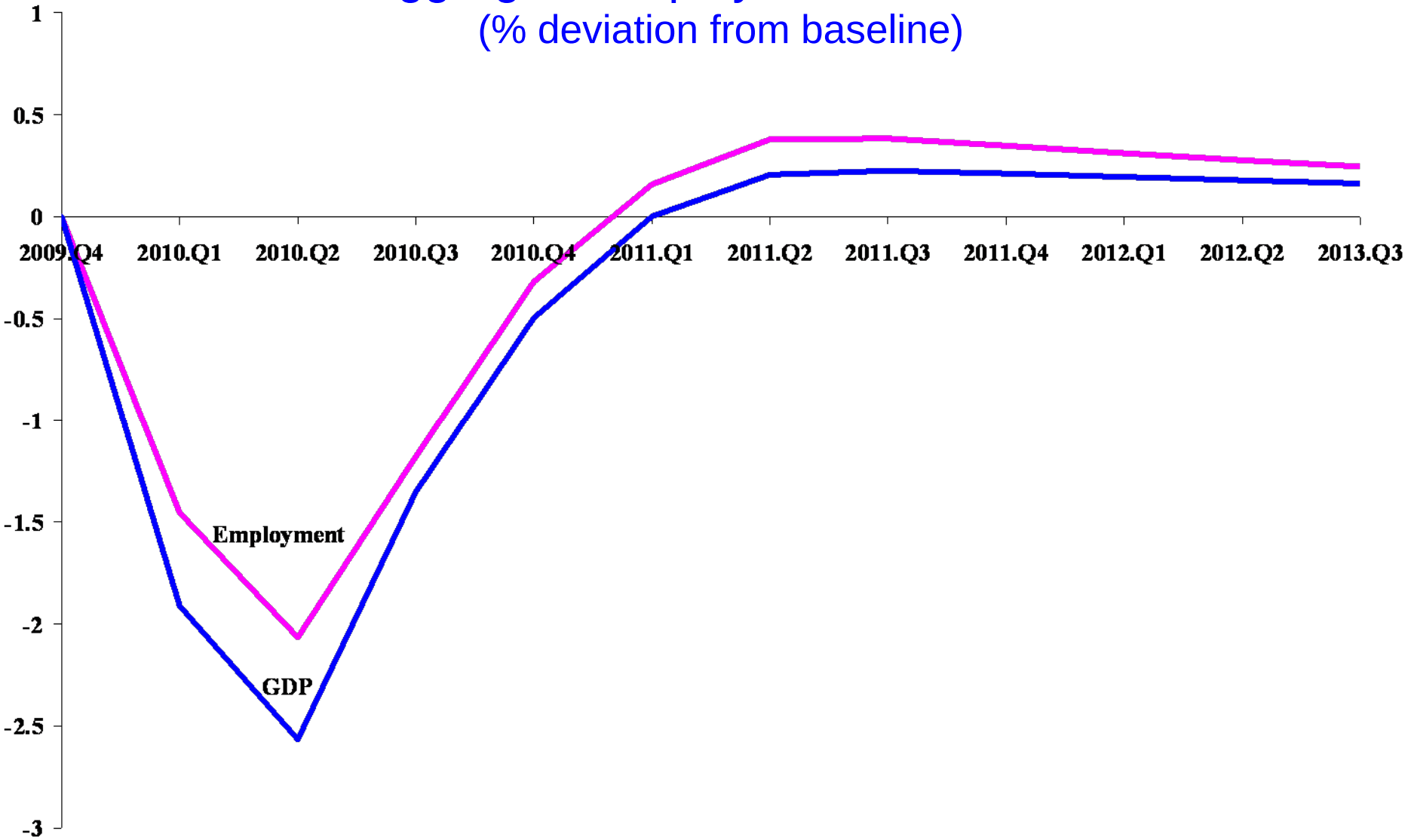
- Wage rate and exchange rate decreases provide offsetting stimuli to the macroeconomy.

- A increase in L productivity to compensate for absent workers would reduce negative impacts by only 10%.

- Medical treatment resilience is relatively small
  - medical treatment provides only a tiny stimulus
  - excess hospital capacity & vaccine stockpiles would not have a great direct spending effect, but could have a major effect by reducing disease spread

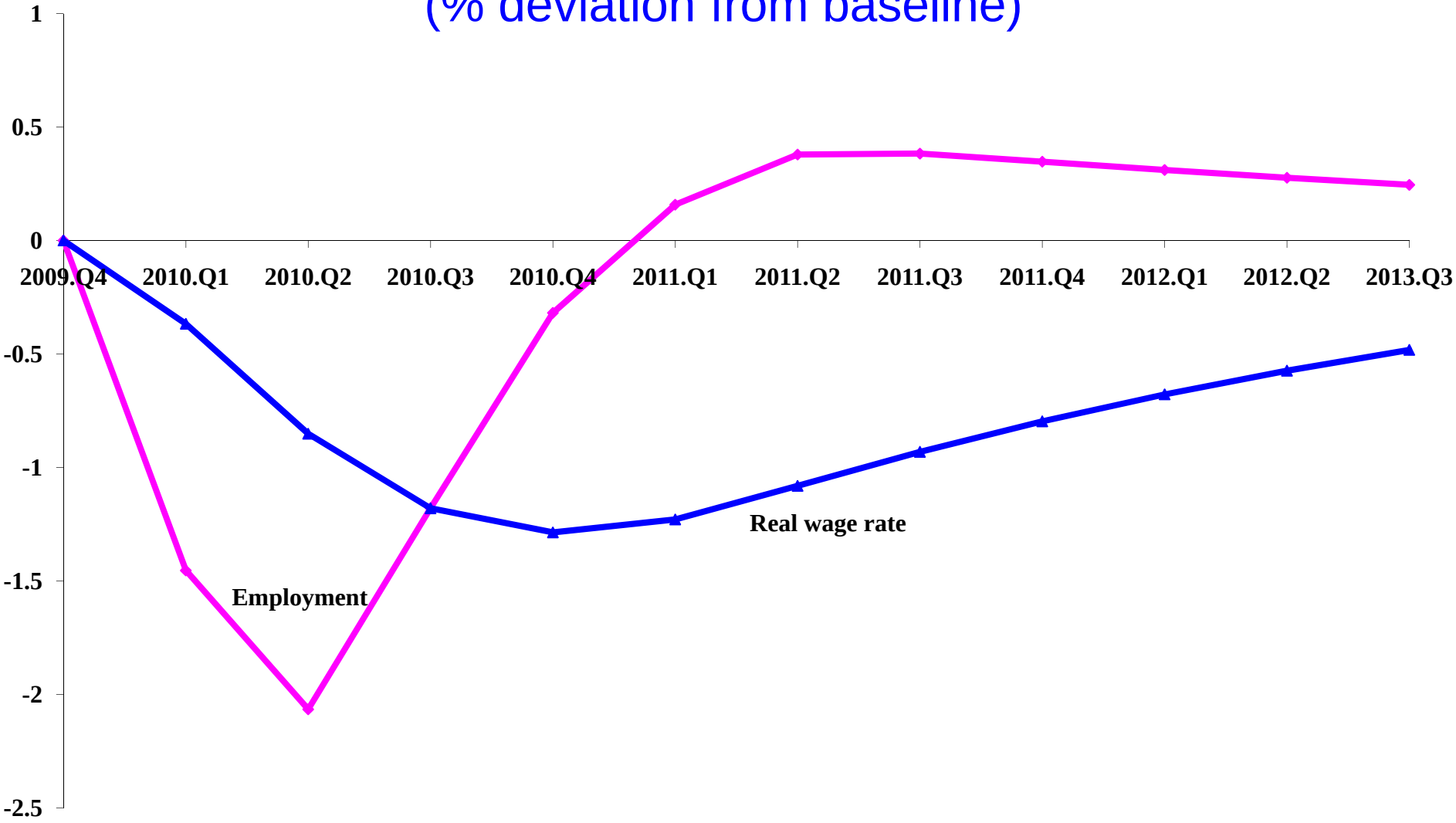
# Aggregate employment and GDP

(% deviation from baseline)

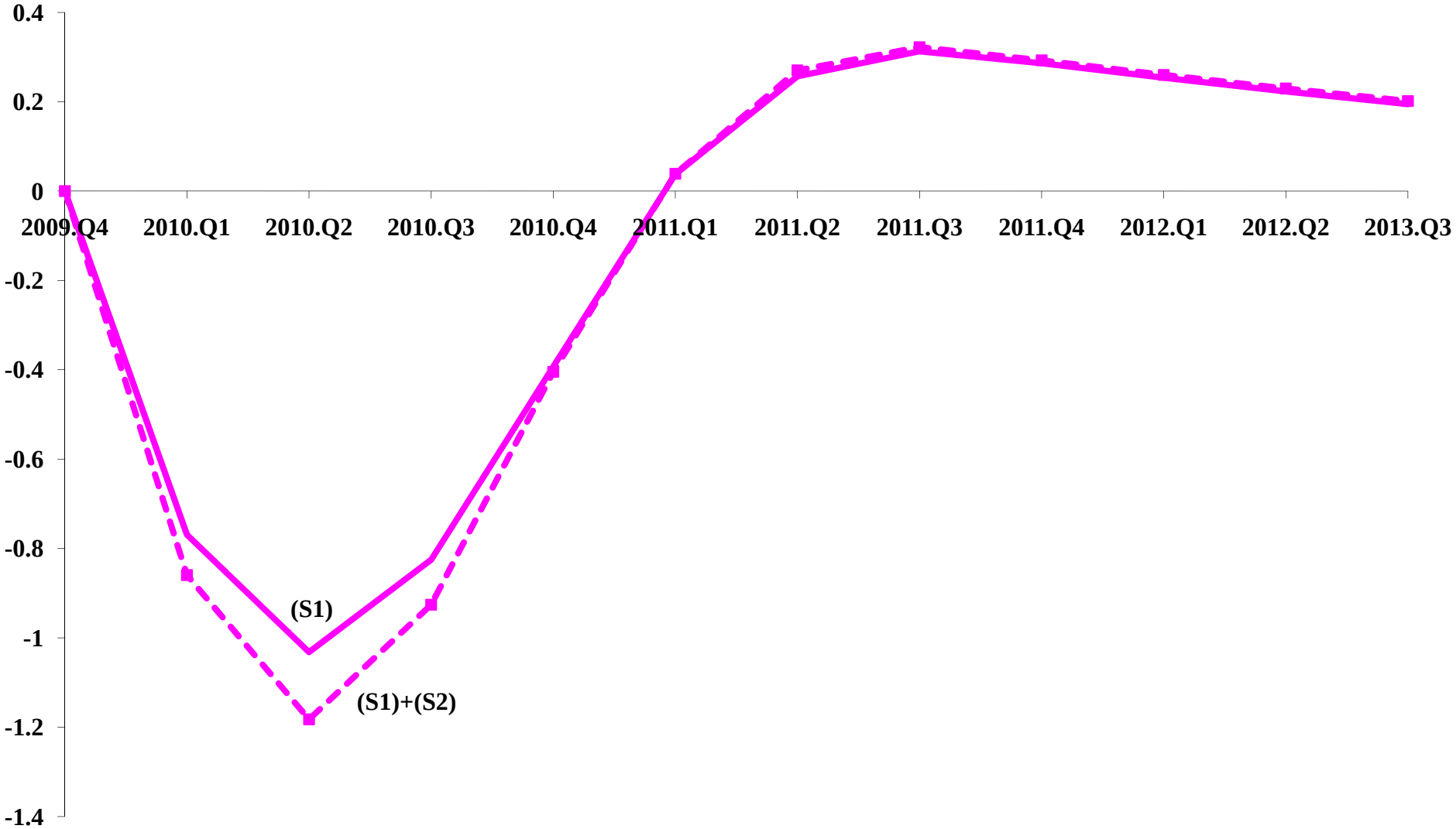


# Aggregate employment and real wage rate

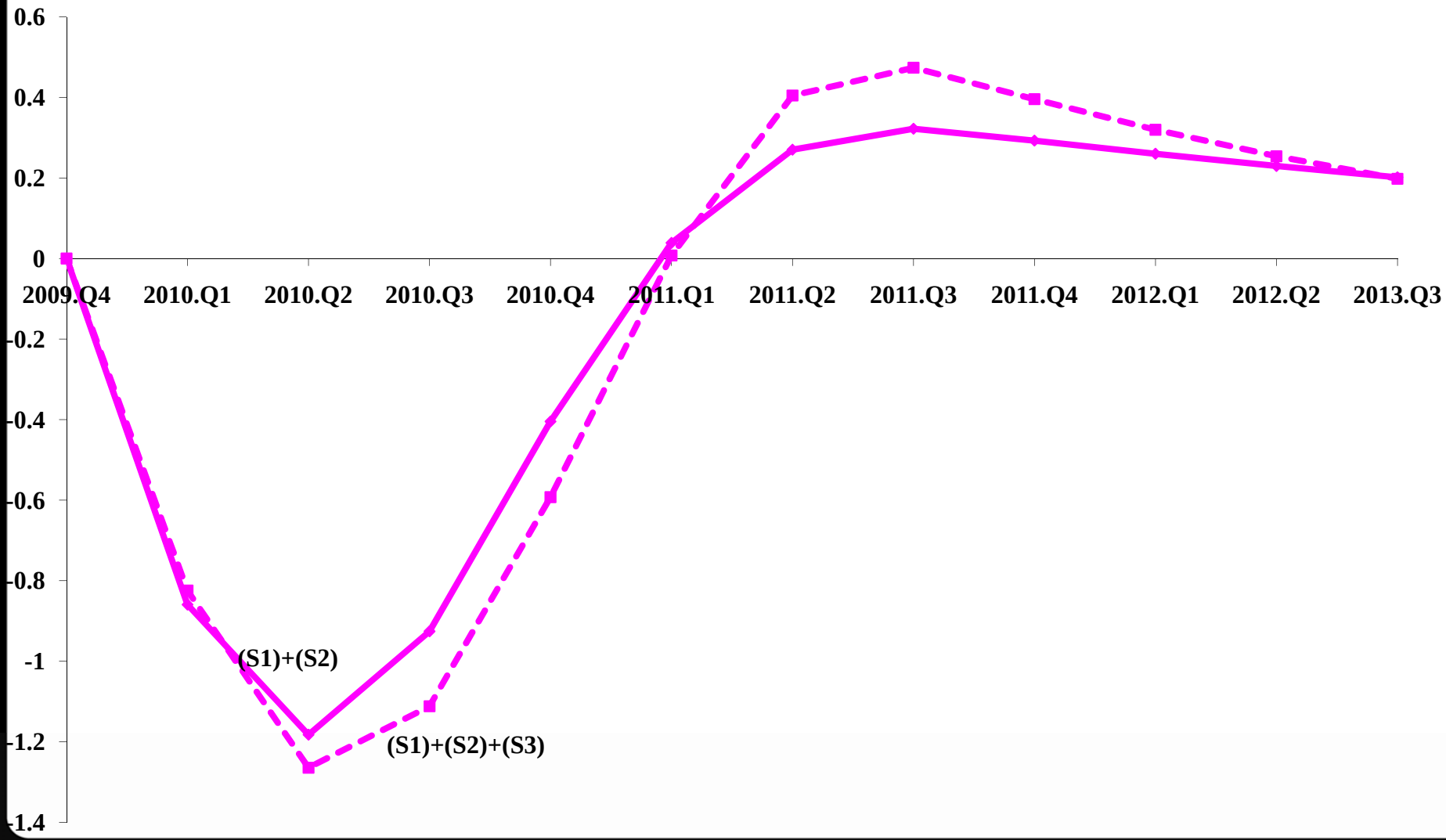
## (% deviation from baseline)



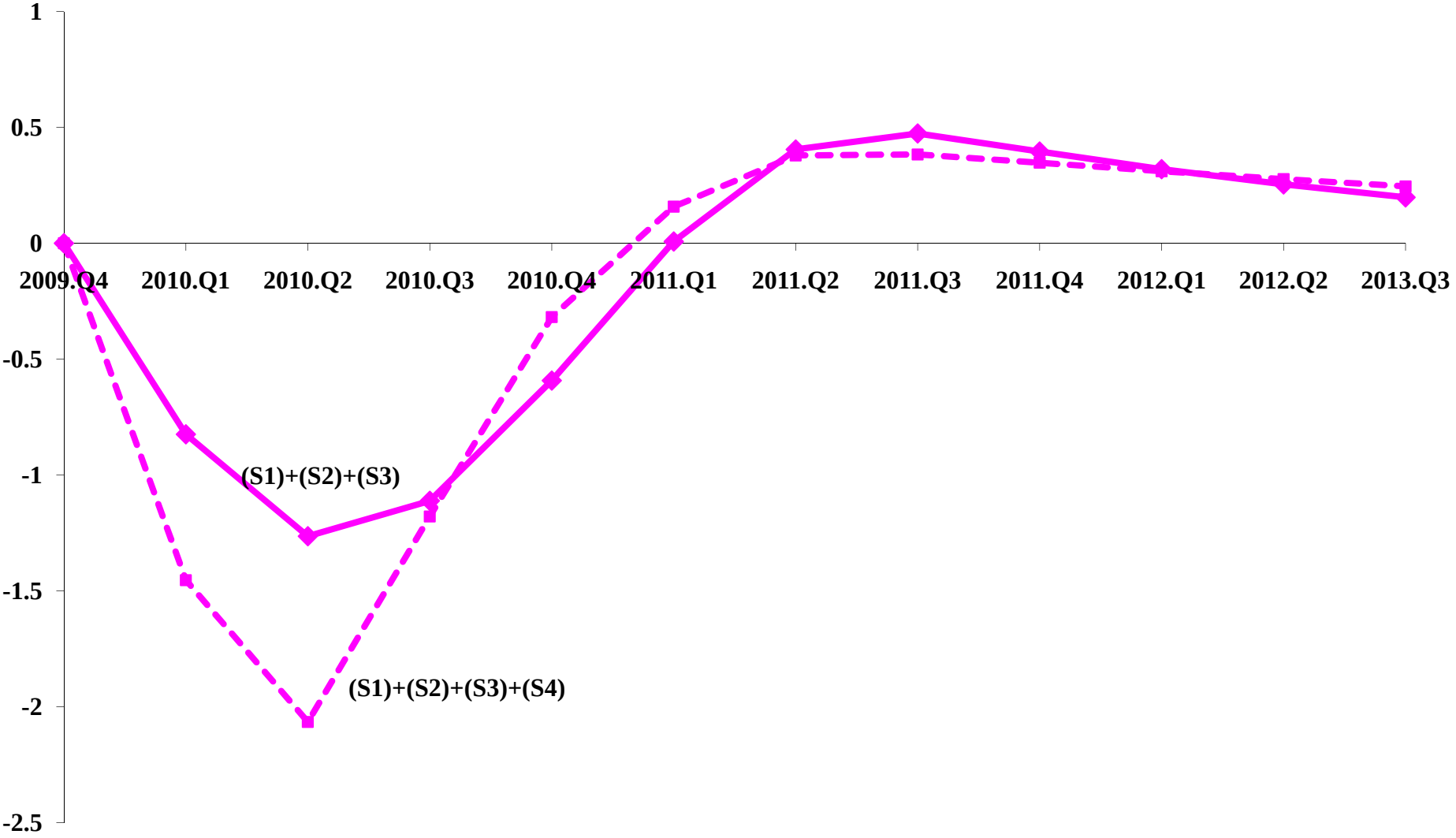
# Effects of tourism (S1) and productivity (S2) on aggregate employment (% deviation from baseline)



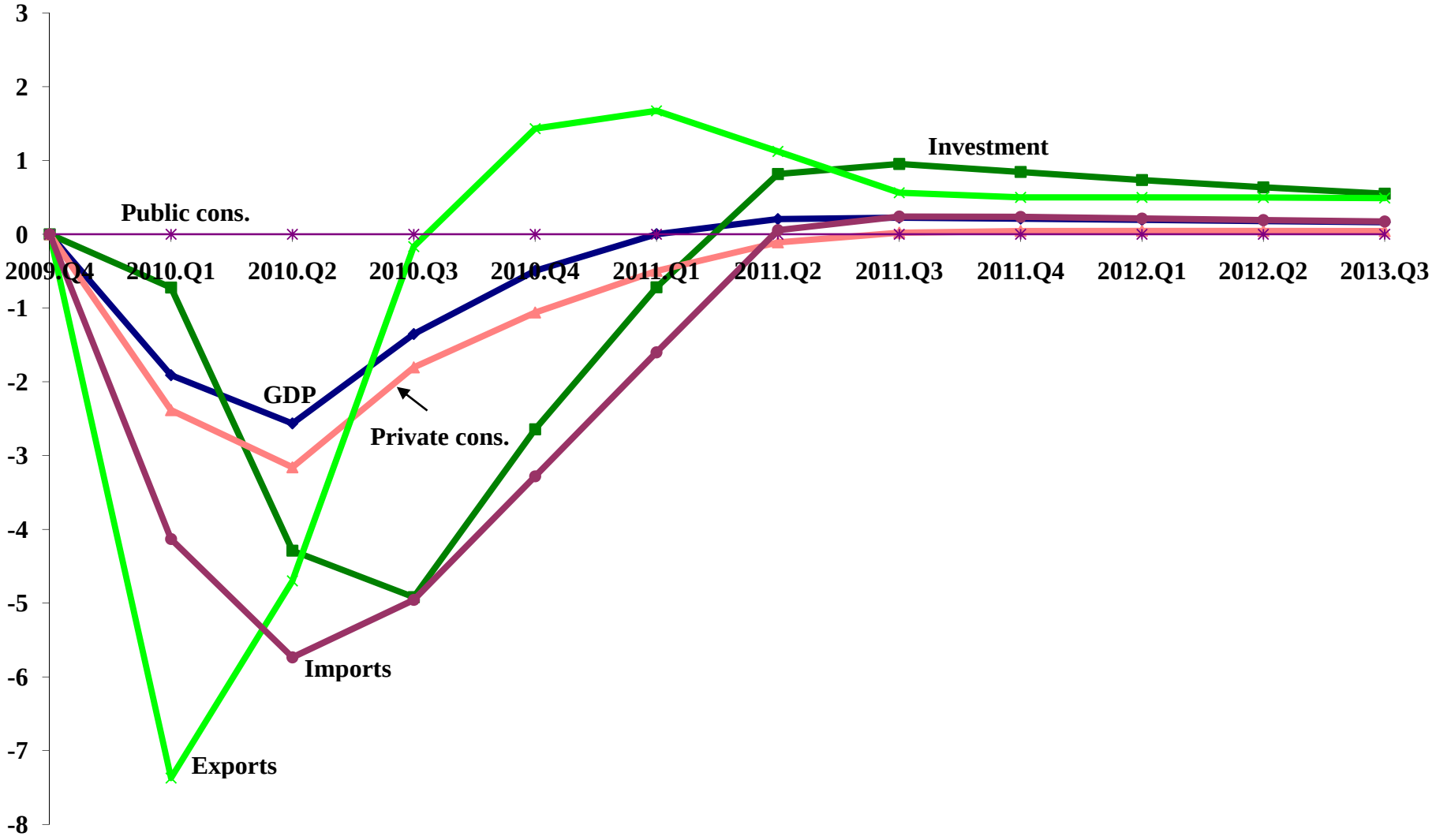
# Effects of medical services (S3) on aggregate employment (% deviation from baseline)



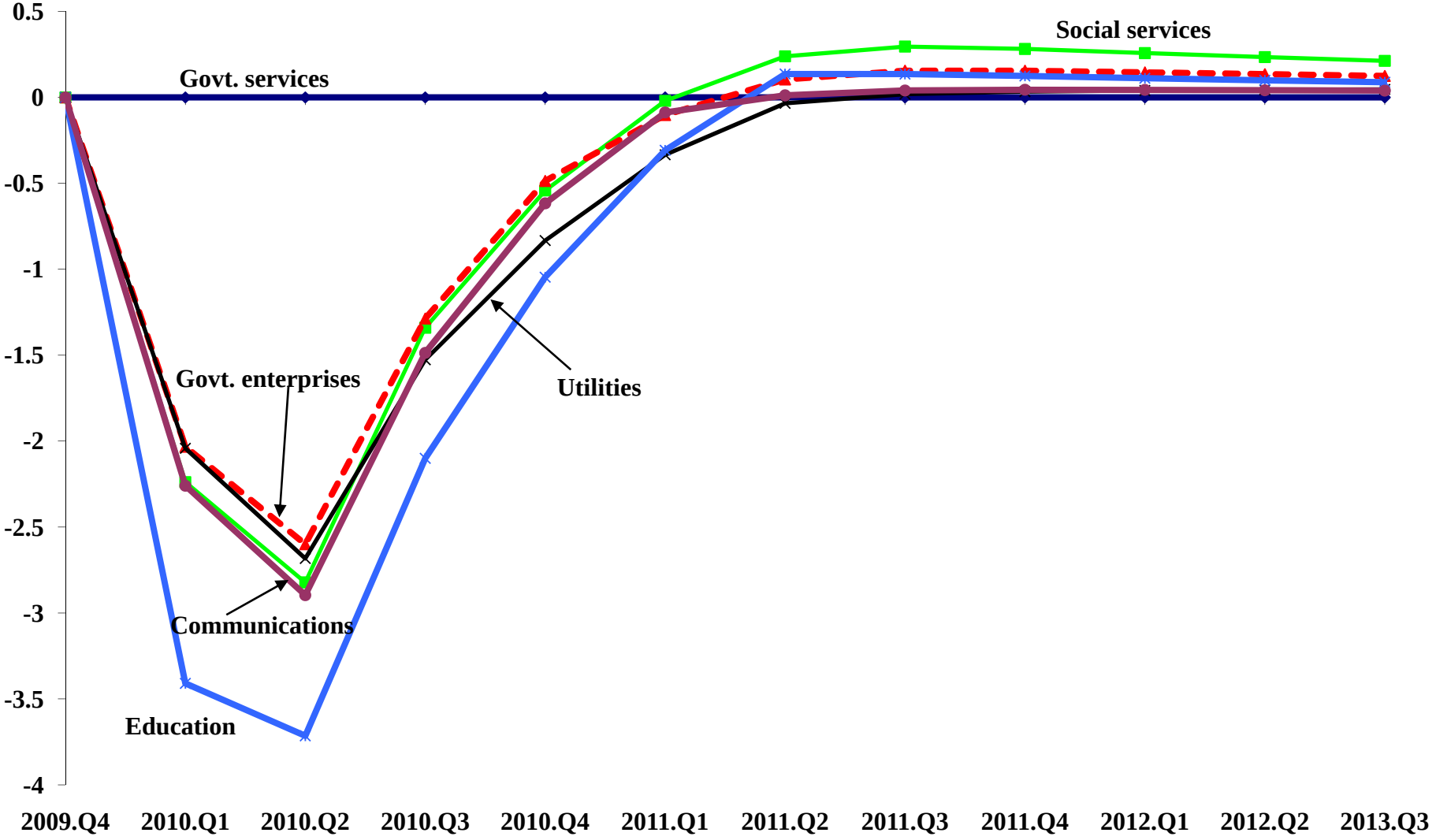
# Effects of entertainment cancelations (S4) on aggregate employment (% deviation from baseline)



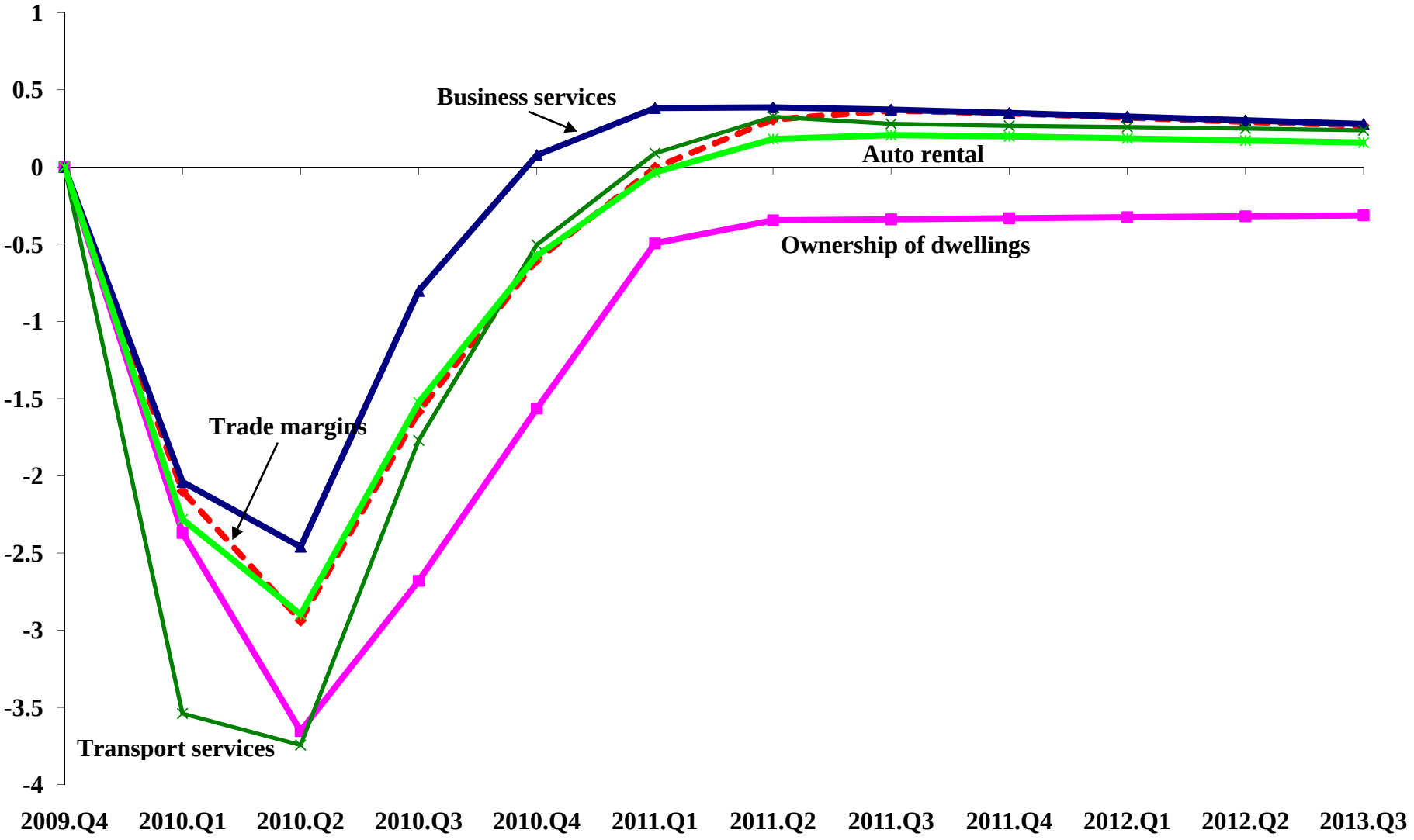
# Expenditure components of GDP
## (% deviation from baseline)



# Output of government-related services
## (% deviation from baseline)



# Output of private-sector services
## (% deviation from baseline)



# Conclusion

- The macroeconomy is somewhat resilient to H1N1 impacts
  - wage rate decrease helps lower cost & stimulate demand
  - exchange rate decrease helps balance of trade
- Other types of resilience relating to health care have relatively little potential to alter the macro outcome directly (though they can do so indirectly by reducing disease spread).
- Impacts are more sensitive to demand side reactions
  - slowdown in tourism & entertainment > L productivity drop
  - reactions have greater impact than illness itself
- The greatest potential to reduce losses is to reduce those aspects of aversion behavior that don’t affect disease spread.

Center for Social and Economic Dynamics at BROOKINGS

Columbia University MAILMAN SCHOOL OF PUBLIC HEALTH

CREATE HOMELAND SECURITY CENTER

PACER A HOMELAND SECURITY CENTER OF EXCELLENCE

# *Resilience in the Face of Pandemics*

## *Discussion…*