Accounting for Differences in Health Spending and Health Outcomes Among OECD Countries

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Big Picture

- Health care expenditure in the United States, in year 2010 was
  - $ 8233 per capita (17.6 percent of GDP),

  two-and-a-half times larger than the OECD average ($3268)

- Life expectancy at birth in the Unites States, in year 2010 was
  - 78.7 years,

  one year below the OECD average

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   Candidate Answers:

- US has one of the highest per capita GDP among OECD countries.

  Higher income means higher spending – including health care.

- US has on of the highest obesity rate among OECD countries.

  Obese population have higher mortality.

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How important are these answers, quantitatively?

What We Ask?

1. How much would the US spend on health care if it had GDP per capita of Japan?

2. What would be the life expectancy in the US (at that level of spending) with obesity rate of Japan?

What We Do?

- We use a model with the following key features
  - Use of health care improves survival rate.
  - There are two types of individuals: obese and non-obese.
  - Types are different in how usage of health care affects survival.
  - Countries differ only in GPD per capita and obesity rate.

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  - Types are different in how usage of health care affects survival.
  - Countries differ only in GPD per capita and obesity rate.
- We focus on efficient allocation – there is no friction in the model.
- We calibrate this model to match the US aggregate observations.
- Use model to predict allocations for other countries.

What We Find?

- OECD countries have on average
  - 62% lower per capita health spending, and
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  - 0.7% higher life expectancy,

  if the GDP per capita and obesity rate was same as other countries.

- This implies that that, on average
  - Roughly 90% of the gap in health care spending, and
  - Roughly 43% of the gap in life expectancy

  can be accounted for by the gap in GDP per capita and obesity rate

Related Literature

- **Hall and Jones (2007):** efficiency and aggregate health spending over time.

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- **Horenstein and Santos (2013):** Differences in relative price of medical care and institutions.

Related Literature

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- **Horenstein and Santos (2013):** Differences in relative price of medical care and institutions.
- Many empirical studies on determinants of health case spending.
- Many empirical studies on the effect of obesity on health care spending and life expectancy.

Outline of the Talk

1. OECD Data
2. Theory – Static model in this talk
3. Calibration
4. Quantitative Exercise
5. Conclusion

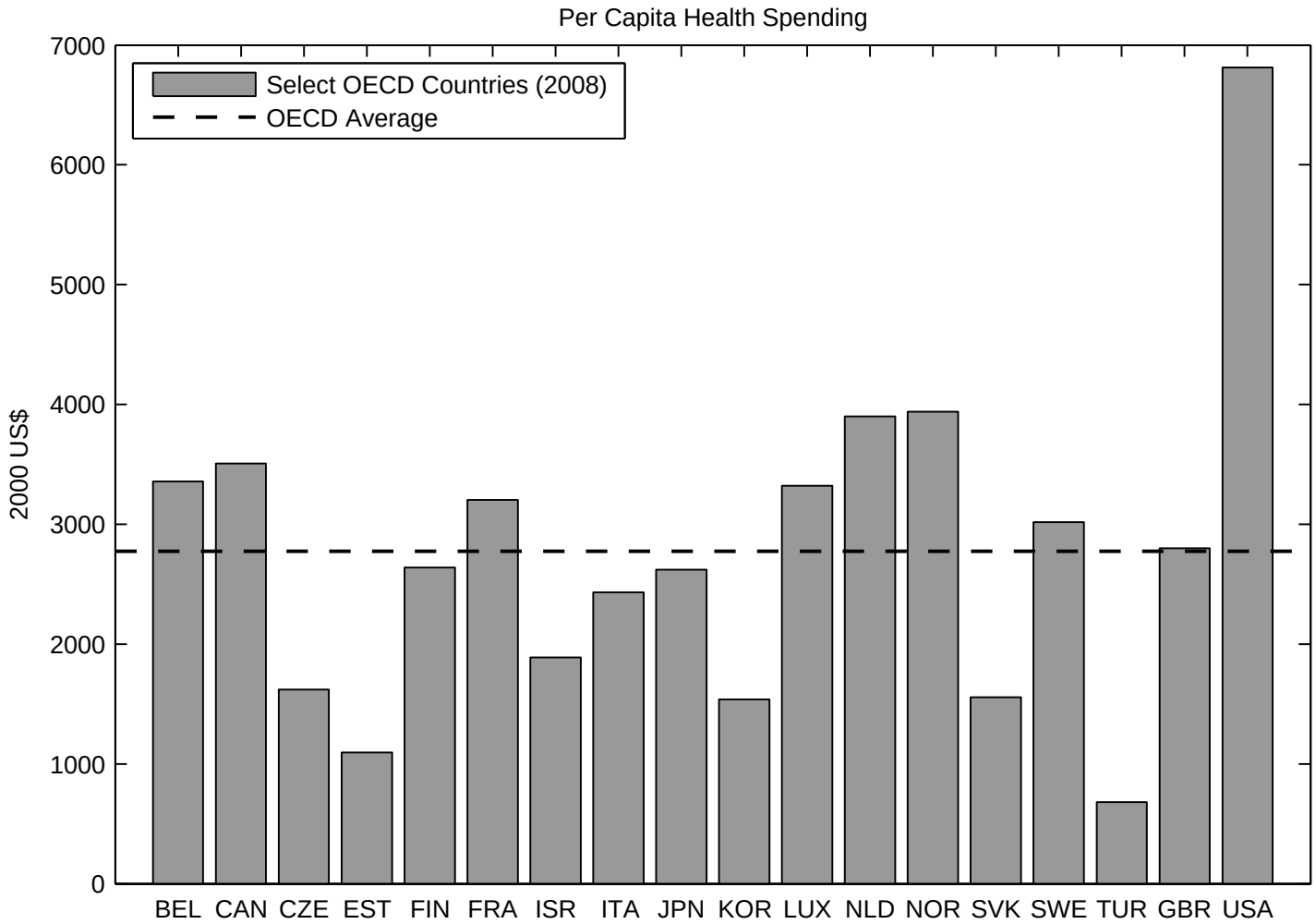
Data

Data

- We use OECD data on aggregate health care spending
  - Health spending includes all public and private expenditures.
- We use OECD data on obesity rate
  - Self-reported obesity (except for Japan)
  - Obesity is defined as $BMI > 30$ for adults.
- We have total of 273 country–year observations.
  - Data available for at least one year for 33 countries.
- In this talk we report data and results for 18 countries in year 2008.

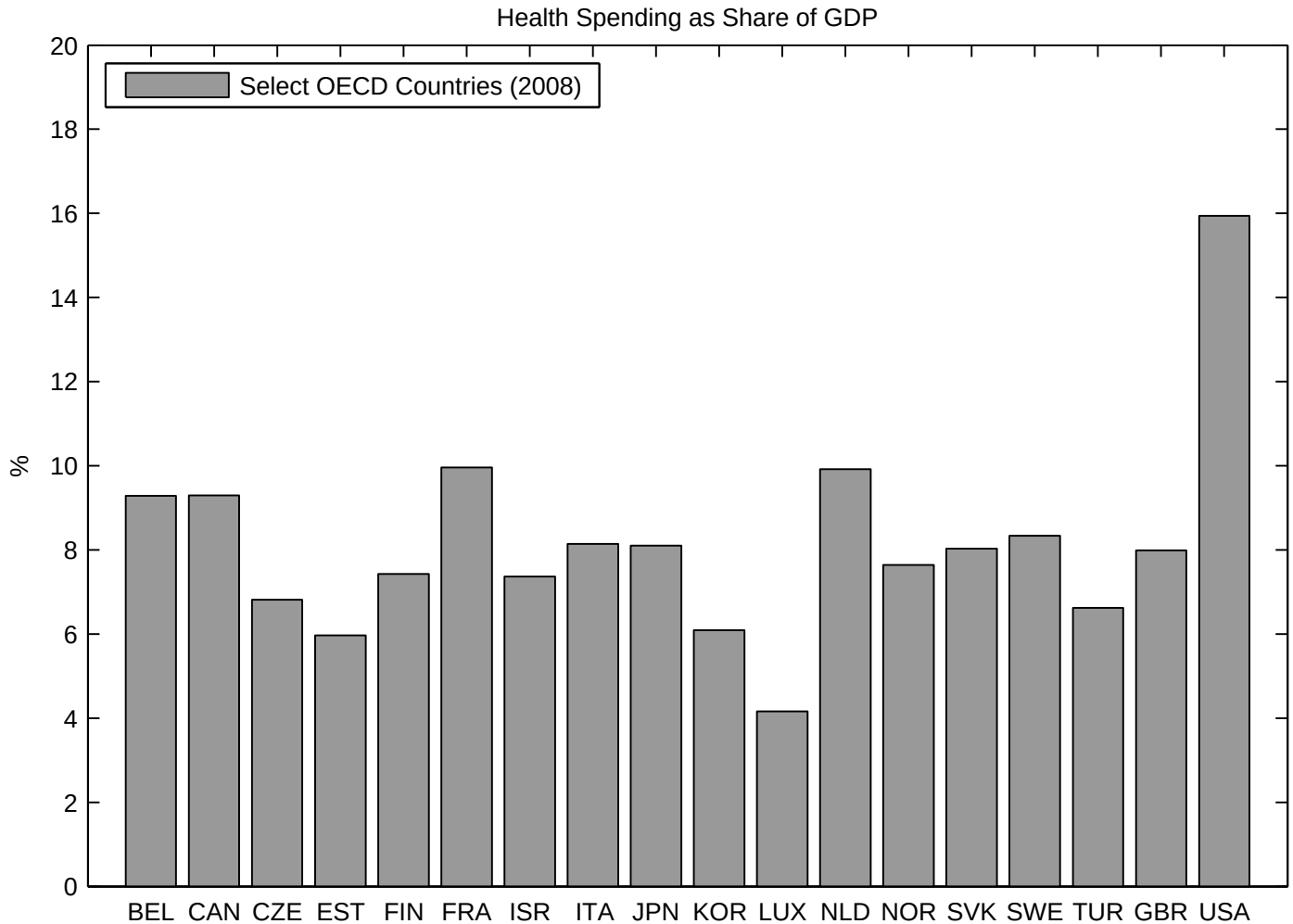
Data

Per Capita Health Care Spending



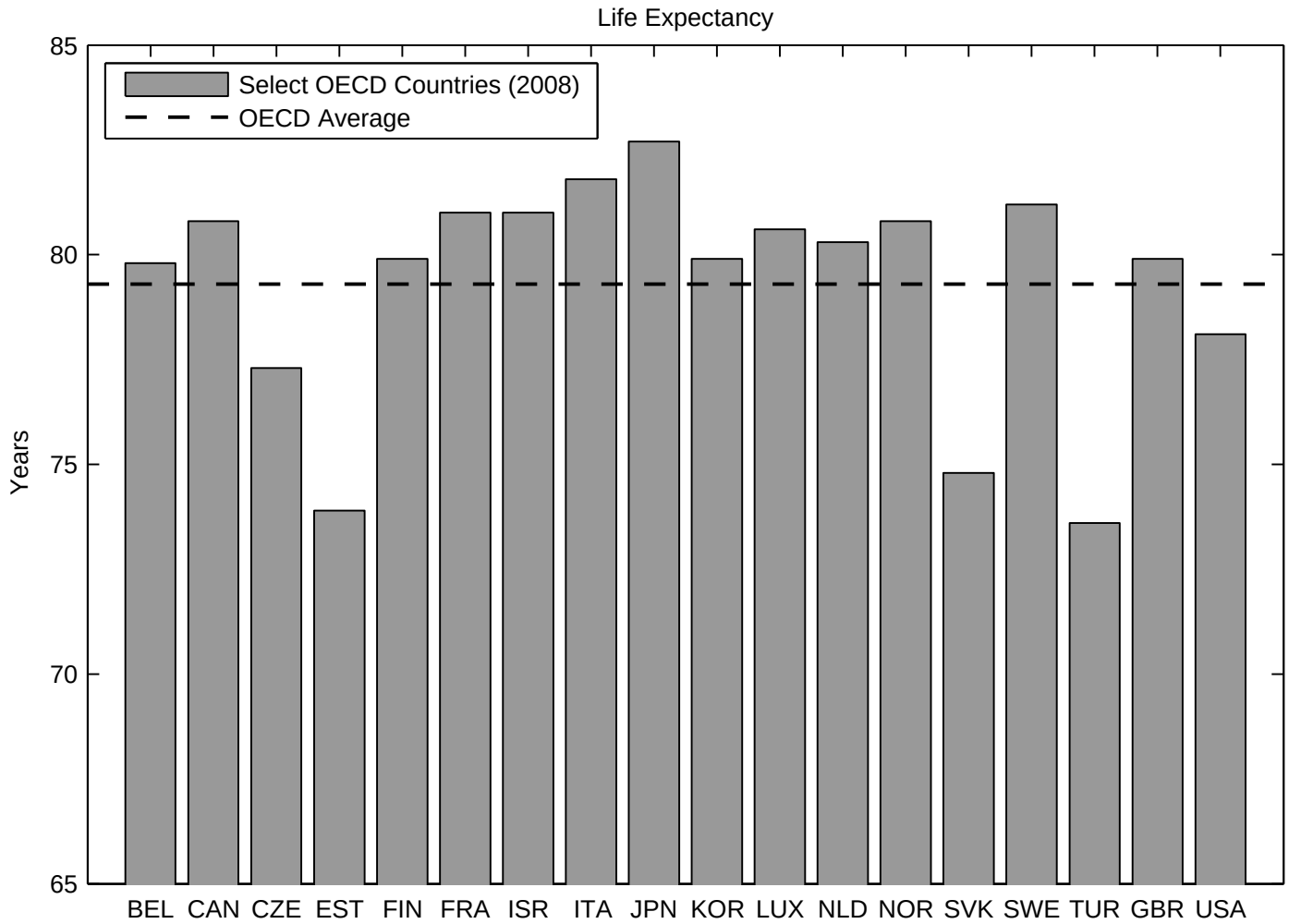
Data

Health Care Spending as Share of GDP



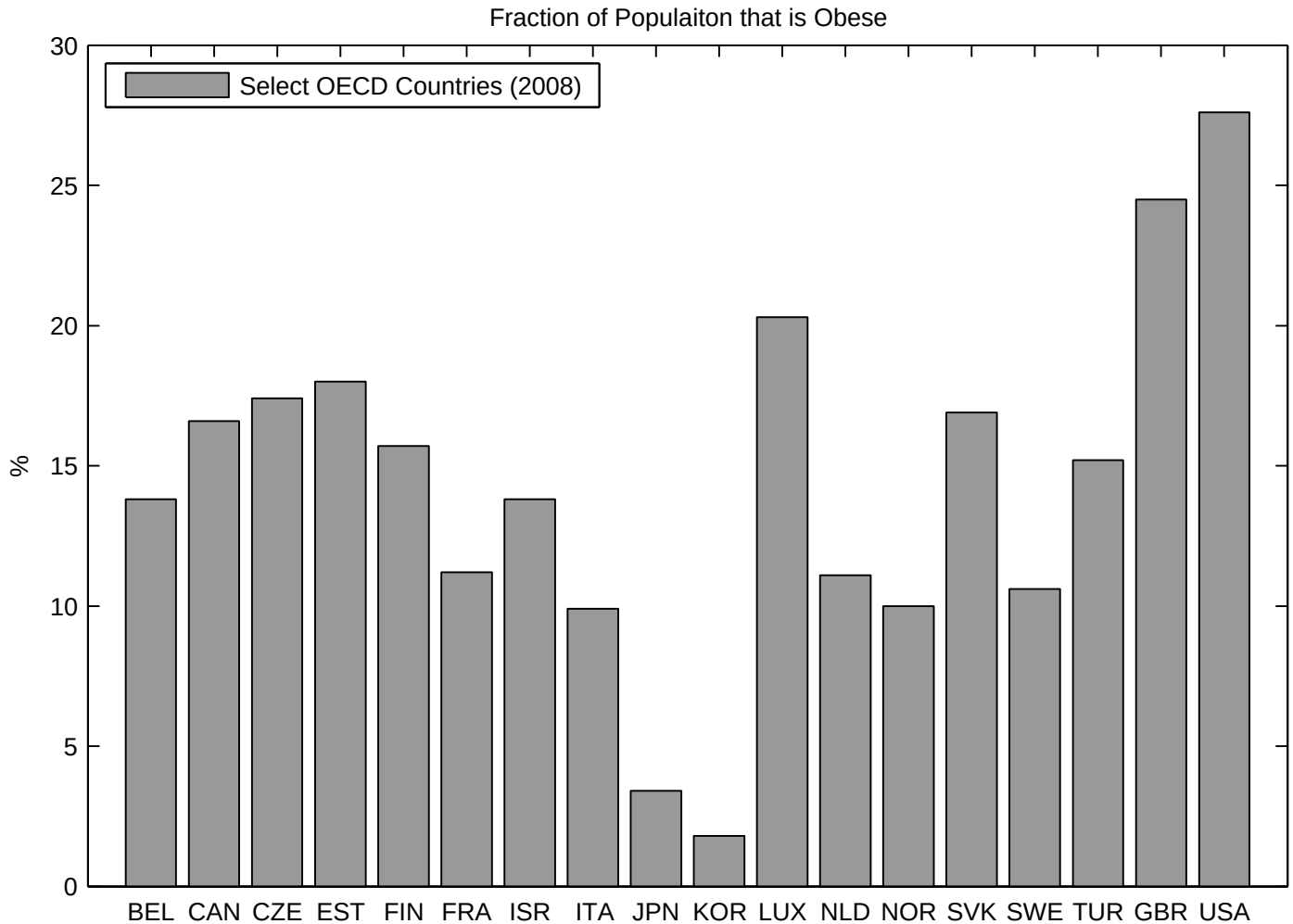
Data

Life Expectancy at Birth



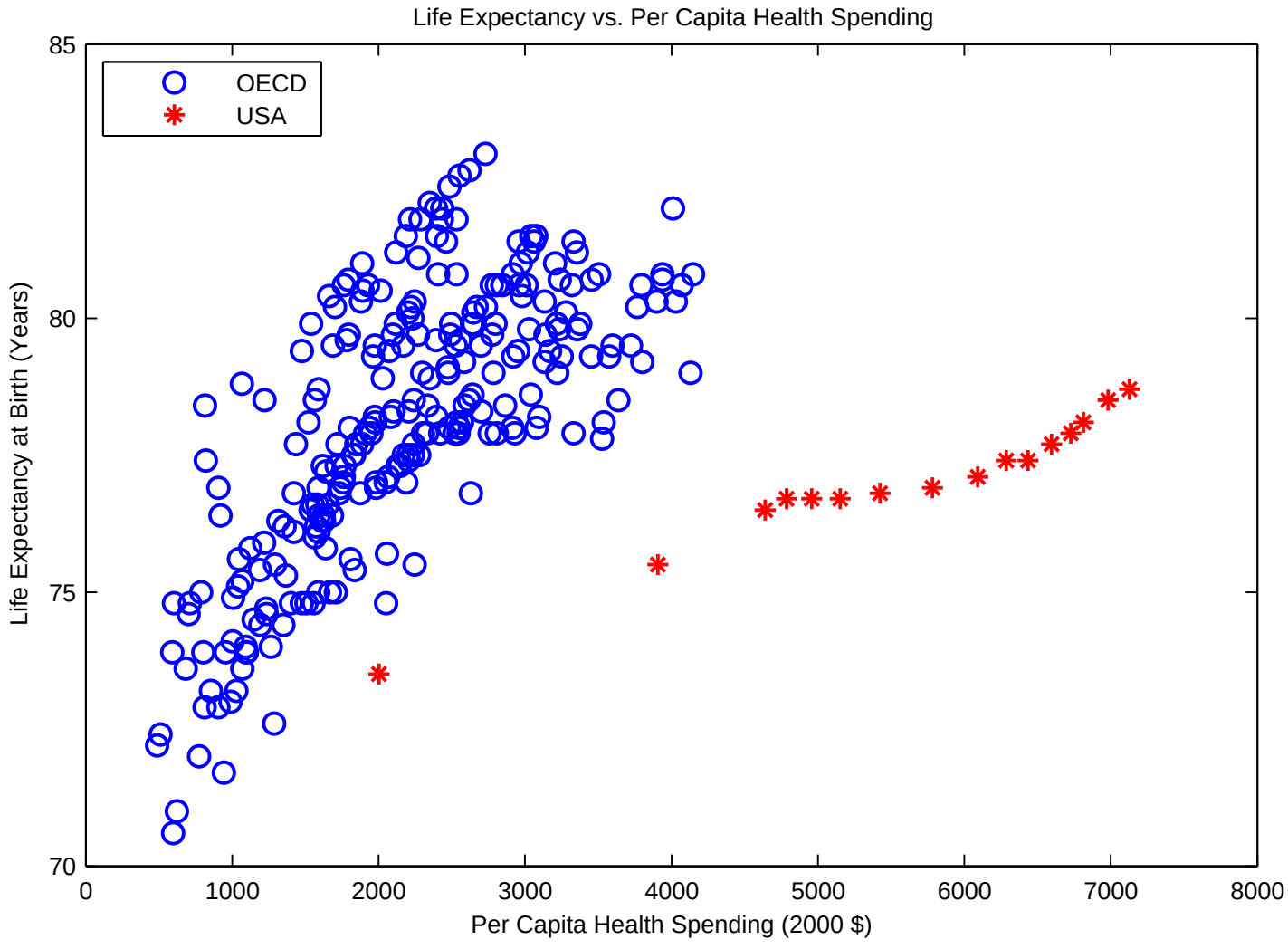
Data

Fraction of Population that is Obese



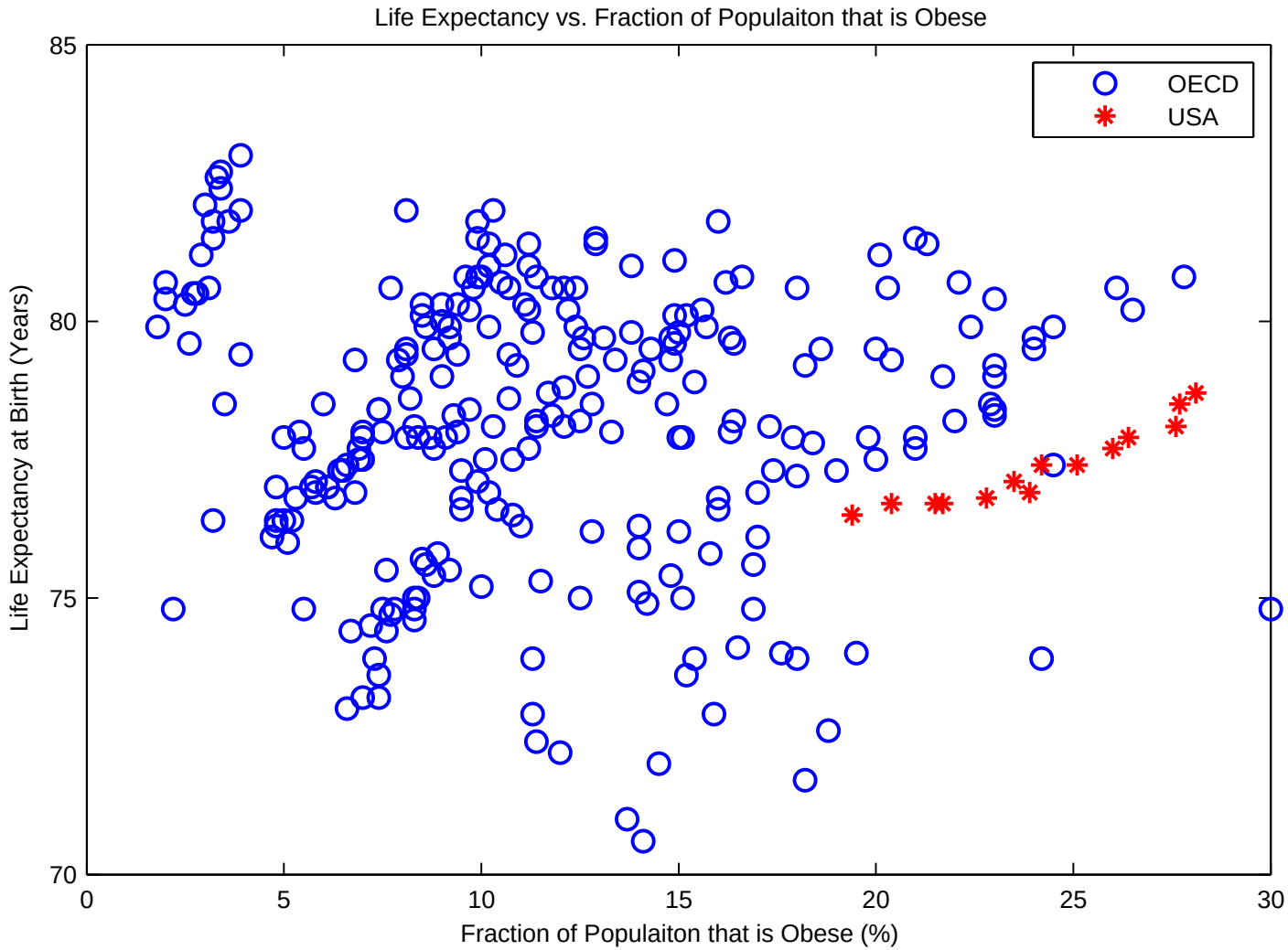
Data

Life Expectancy vs. Health Care Spending



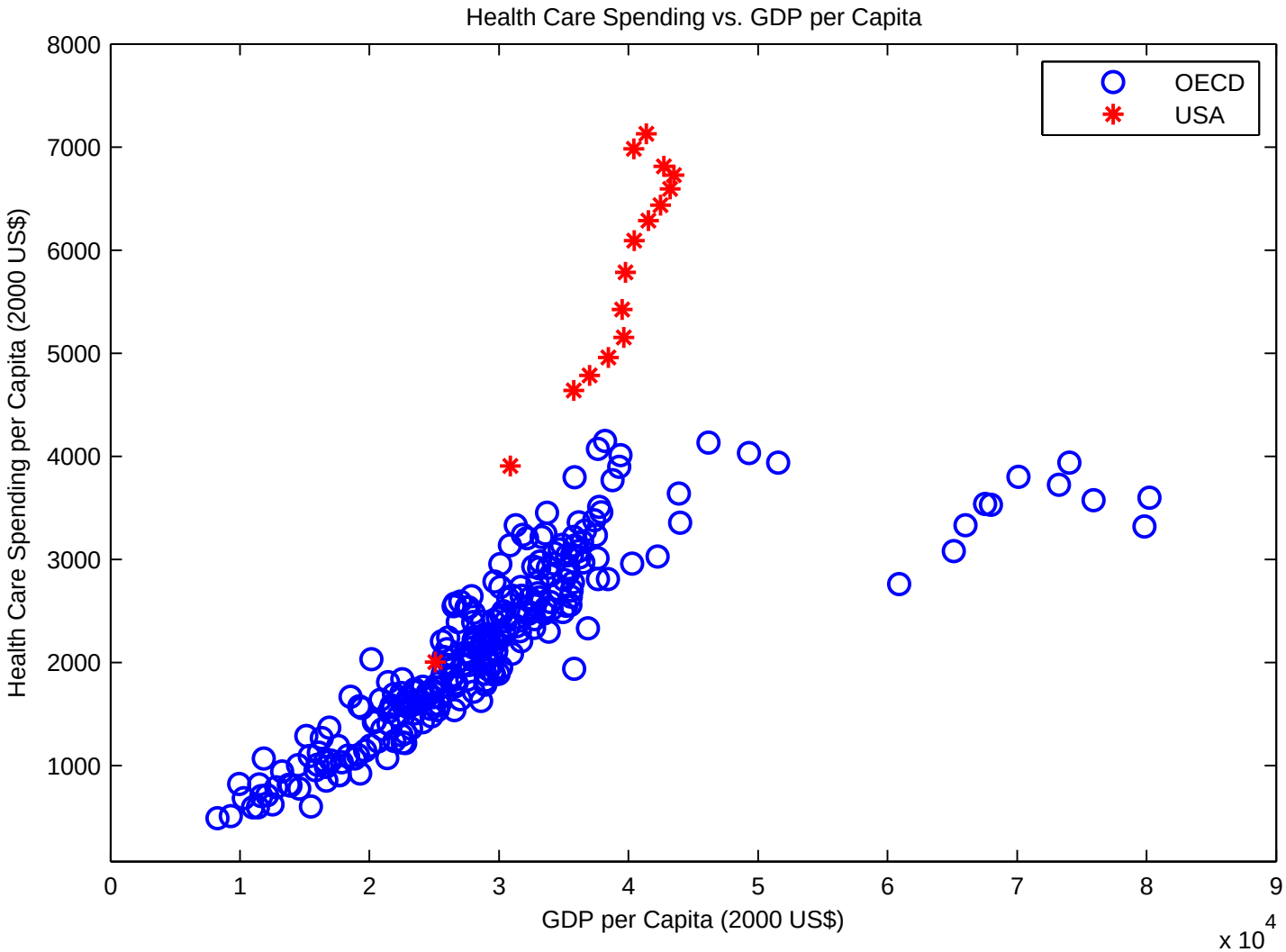
Data

Life Expectancy vs. Obesity



Data

Health Care Spending vs. GDP



Theory: Simple Static Model

Model

Individuals

- There are two types, $i = ob, nob$, (potentially) infinitely lived
- Type i have constant *heath status* x_i which determines mortality

$$\int_0^\infty \exp\left(-t/x_i\right) u\left(c_i(t)\right) dt \qquad , i = ob, nob$$

- Type i spend constant flow h_i on health.

$$x_i = f_i\left(h_i\right), \quad -f_i'', f_i' > 0$$

- Everyone has constant endowment y.

$$\int_0^\infty \exp\left(-t/x_i\right)\left(c_i(t) + h_i - y\right) dt = 0$$

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Model

Efficient Allocation of Consumption and Health Care

- Let ψ be fraction obese population (type $i = ob$)
- Consider the following planning problem

$$\max \psi \int_0^\infty e^{-(t/x_{ob})} u\left(c_{ob}(t)\right) dt + (1-\psi) \int_0^\infty e^{-(t/x_{nob})} u\left(c_{nob}(t)\right) dt$$

s.t.

$$\psi \int_0^\infty e^{-(t/x_{ob})} \left(c_{ob}(t) + h_{ob} - y\right) dt + (1-\psi) \int_0^\infty e^{-(t/x_{nob})} \left(c_{nob}(t) + h_{nob} - y\right) dt = 0$$

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- Consumption allocation will the same across time and type.

Model

Efficient Allocation of Consumption and Health Care

- Let ψ be fraction obese population (type $i = ob$)
- Consider the following planning problem

$$\max \psi x_{ob} u\left(c_{ob}\right) + (1-\psi) x_{nob} u\left(c_{nob}\right)$$

s.t.

$$\psi x_{ob}\left(c_{ob} + h_{ob} - y\right) + (1-\psi) x_{nob}\left(c_{nob} + h_{nob} - y\right) = 0$$

$$x_i = f_i\left(h_i\right)$$

- Consumption allocation will the same across time and type.
- The problem simplifies to a static maximization problem.

Model

Characterizing Allocations

- First order condition

$$\frac{u(c)}{u'(c)} = \frac{x_i}{f_i'(h_i)}$$

Model

Characterizing Allocations

- First order condition – interpretation

$$\underbrace{\frac{x_i u(c)}{u'(c)}}_{\text{marginal value of life}} = \underbrace{\frac{x_i^2}{f_i'(h_i)}}_{\text{marginal cost of life}}$$

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- Assume

$$u(c) = b + \frac{c^{1-\gamma}}{1-\gamma}, \text{ and } x_i = f_i(h_i) = A_i h_i^{\eta_i}$$

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- Assume

$$u(c) = b + \frac{c^{1-\gamma}}{1-\gamma}, \text{ and } x_i = f_i(h_i) = A_i h_i^{\eta_i}$$

- Then

$$bc^{\gamma} - \frac{c}{1-\gamma} = \frac{h_i}{\eta_i}$$

Model

Properties of Static Model

$$bc^{\gamma} - \frac{c}{1-\gamma} = \frac{h_i}{\eta_i}$$

- If $h_{ob} > h_{nob}$ if and only if $\eta_{ob} > \eta_{nob}$.

- A_i does not affect this equation. This is useful for calibration.

Calibration

Calibration

Health Expenditure of Obese vs. Non-Obese

- Use Medical Expenditure Panel Survey (MEPS) from 1997 to 2010.
- Define obesity if $BMI \geq 30$ (≥ 28 if younger than 20)
- Calculate average health care spending by obese and non-obese
- Obese people spend on average %37.8 more.
- Assume this ratio is constant for the period we study (in the US)
- We split the aggregate health care spending according to this ratio.

Calibration

Parameters of Survival function: η_i

$$bc^{\gamma} - \frac{c}{1-\gamma} = \frac{h_i}{\eta_i}$$

- Use data on health care spending by type and obesity rate.
- Choose b, η_{ob} and η_{nob} such that
  - Health care spending data in year 2000 solves the FOC.
  - Value of statistical life is \$9 million.

Calibration

Parameters of Survival function: A_i

$$x_i = A_i h_t^{\eta_i}$$

- Use data on life expectancy for the whole population, 1959 to 2010.

- Regress life expectancy data on common time trend.

- Take unexplained residual for the U.S., call it Z_t.

- Use data on obesity rate, health care spending and calibrated η_i's

$$Z_t = \psi_t A_{ob} h_{t,ob}^{\eta_{ob}} + (1 - \psi_t) A_{nob} h_{t,nob}^{\eta_{nob}}$$

  to find A_{ob} and A_{nob}

Calibration

Summary

Parameter		Value
γ		2
b	value of statistical life = \$9 mil	0.0002
ψ	fraction of obese population, U.S. (OECD)	21.7%
y	endowment (C+G), NIPA	30094
	survival function parameters	
η_{ob}		0.065
η_{nob}		0.045
A_{ob}		26.48
A_{nob}		49.12

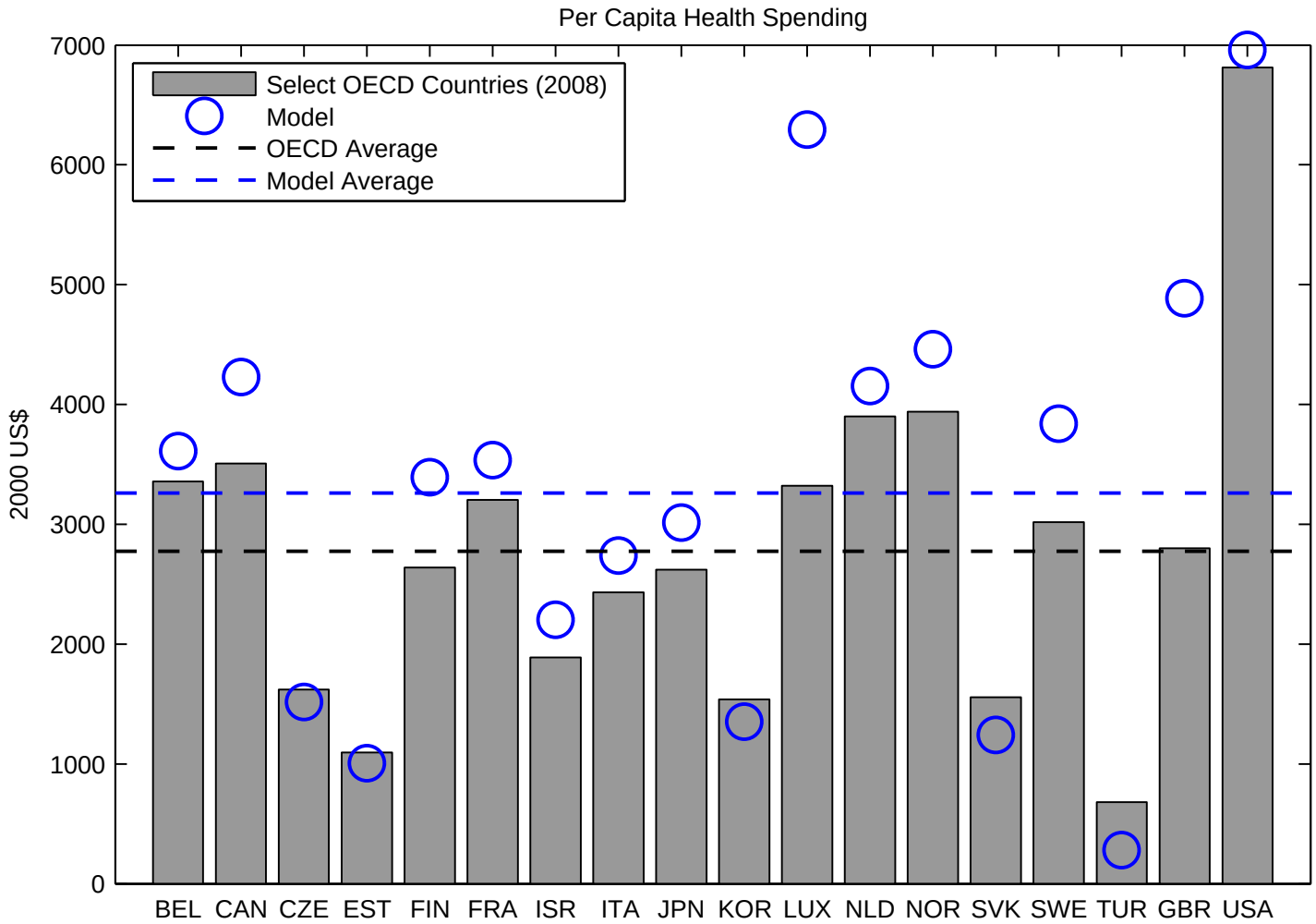
Quantitative Exercise

Quantitative Exercise

- The model is calibrate to match the US observation in year 2000.
- Generate health care spending and life expectancy for country j
  - Assuming US has GDP per capita and obesity rate of country j
- Compare model generated allocation with OECD data.

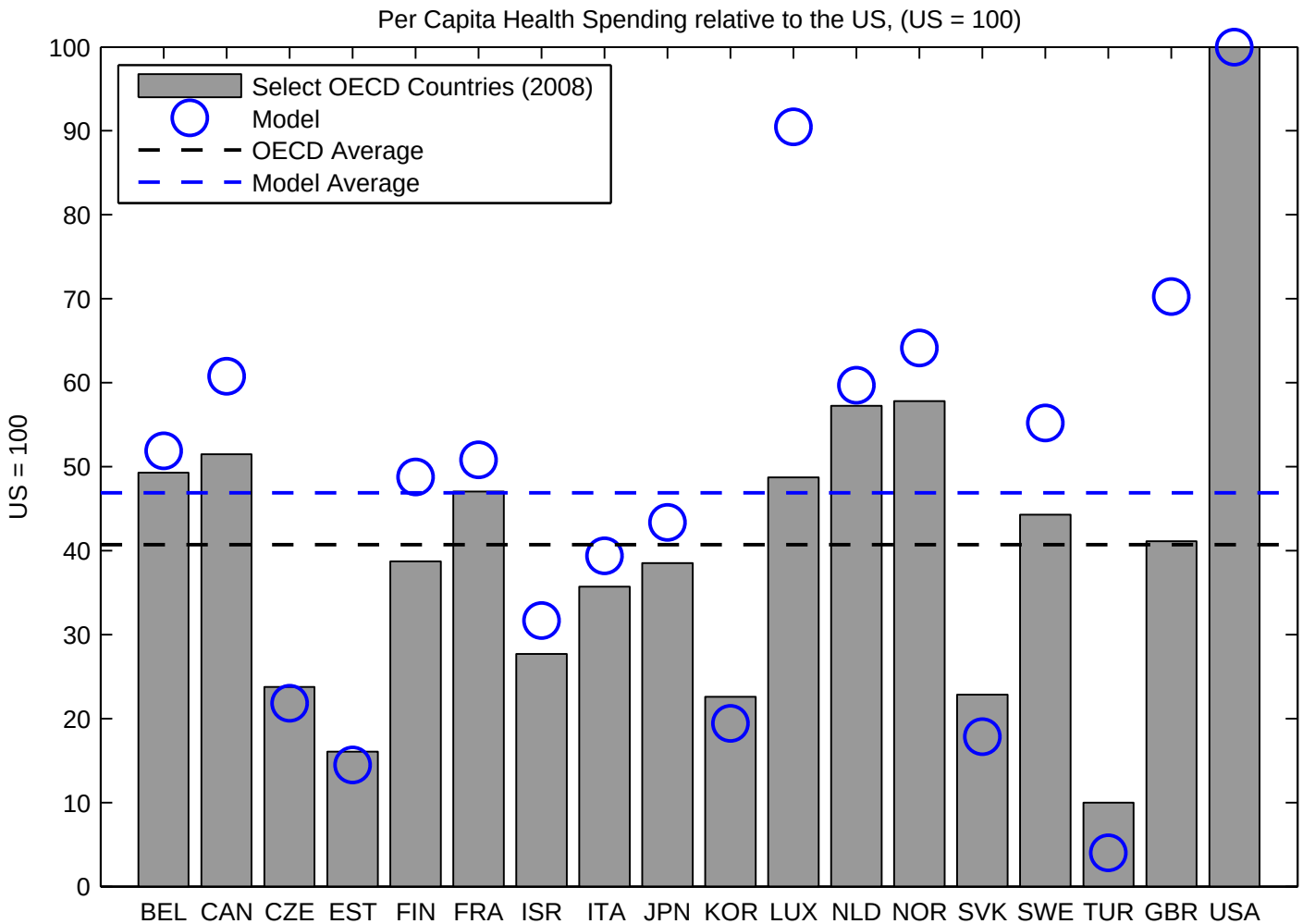
Data vs Model

Per Capita Health Care Spending



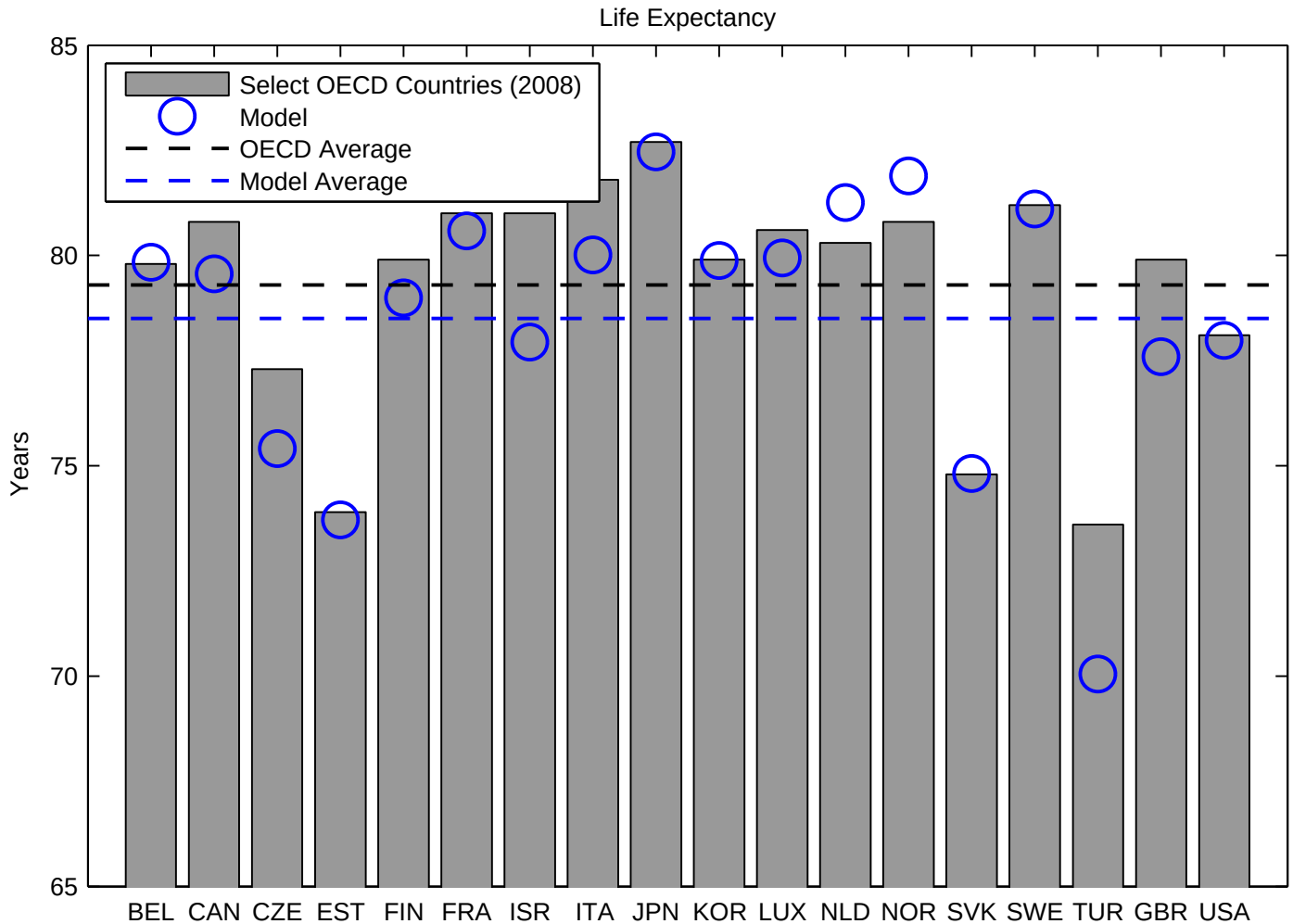
Data vs Model

Per Capita Health Care Spending, Relative to the US



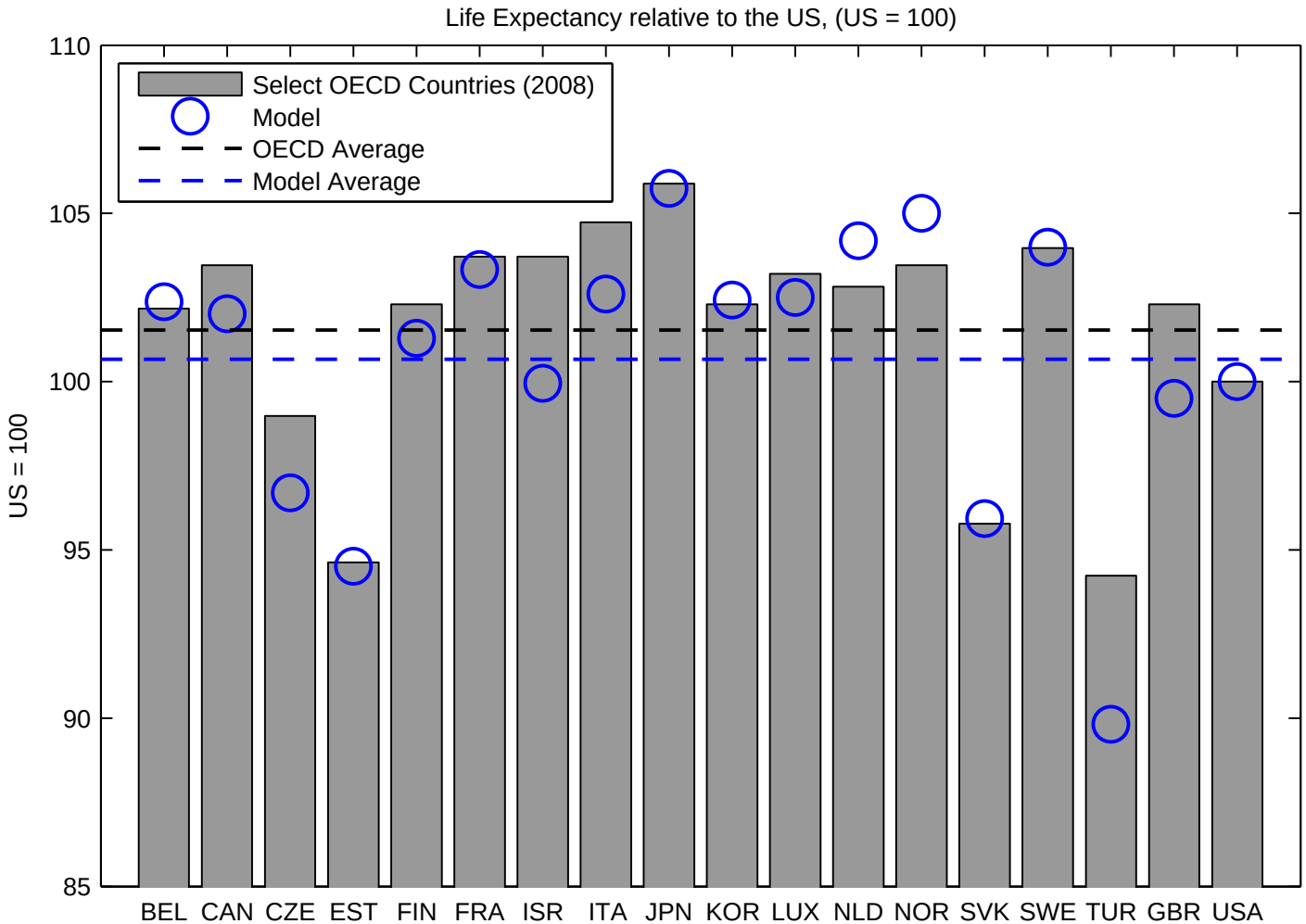
Data vs Model

Life Expectancy at Birth



Data vs Model

Life Expectancy at Birth, relative to the US (US = 100)



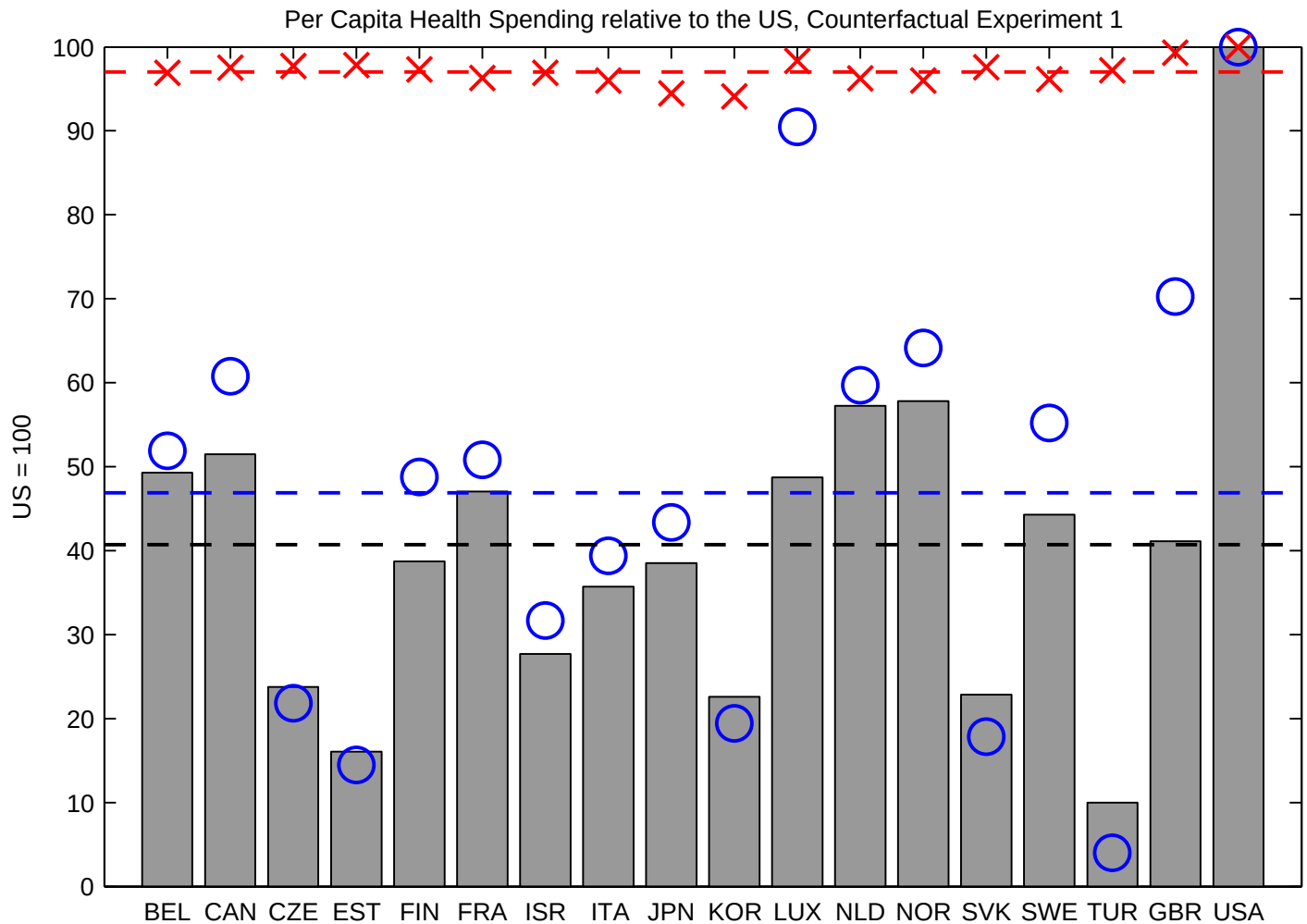
Experiment

GDP Per Capita or Obesity Rate?

- Which one these factors is more important?
- We repeat our exercise by
  1. Keeping GDP per capita at the US level, only vary obesity rate.
  2. Keeping obesity rate at the US level, only vary GDP per capita.

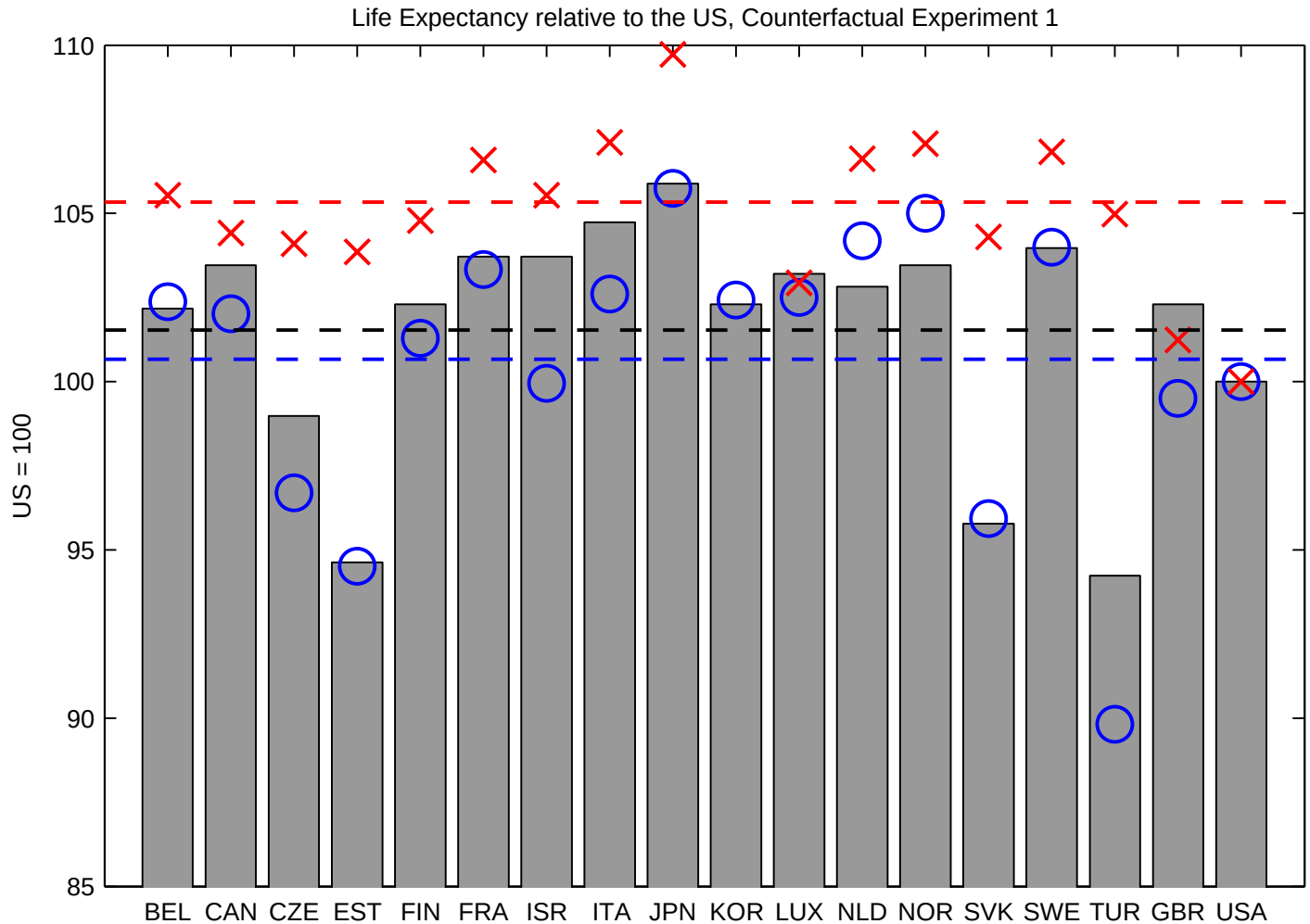
Experiment 1: Holding GDP per capita at US level

Per Capita Health Care Spending, Relative to the US



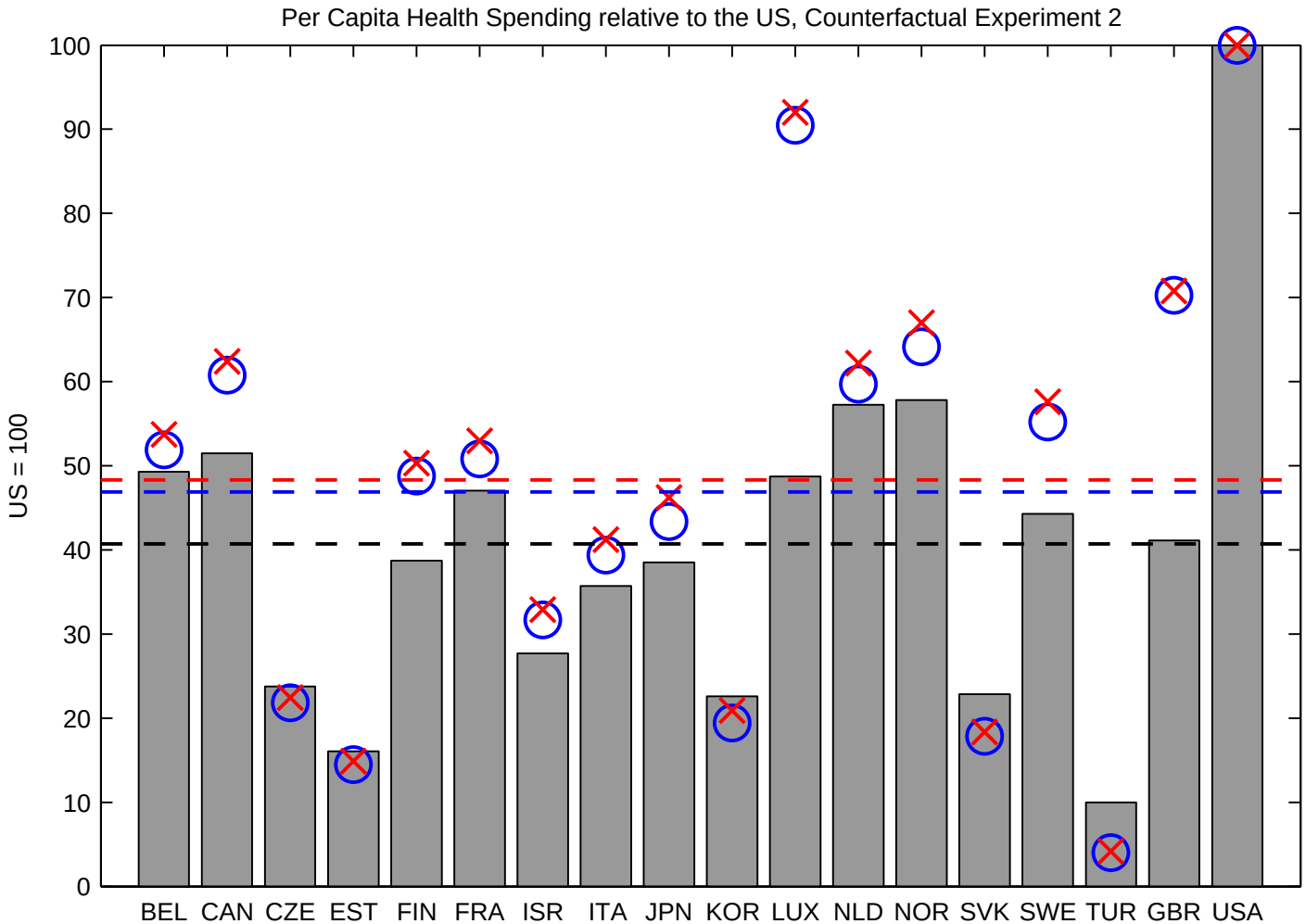
Experiment 1: Holding GDP per capita at US level

Life Expectancy at Birth, relative to the US (US = 100)



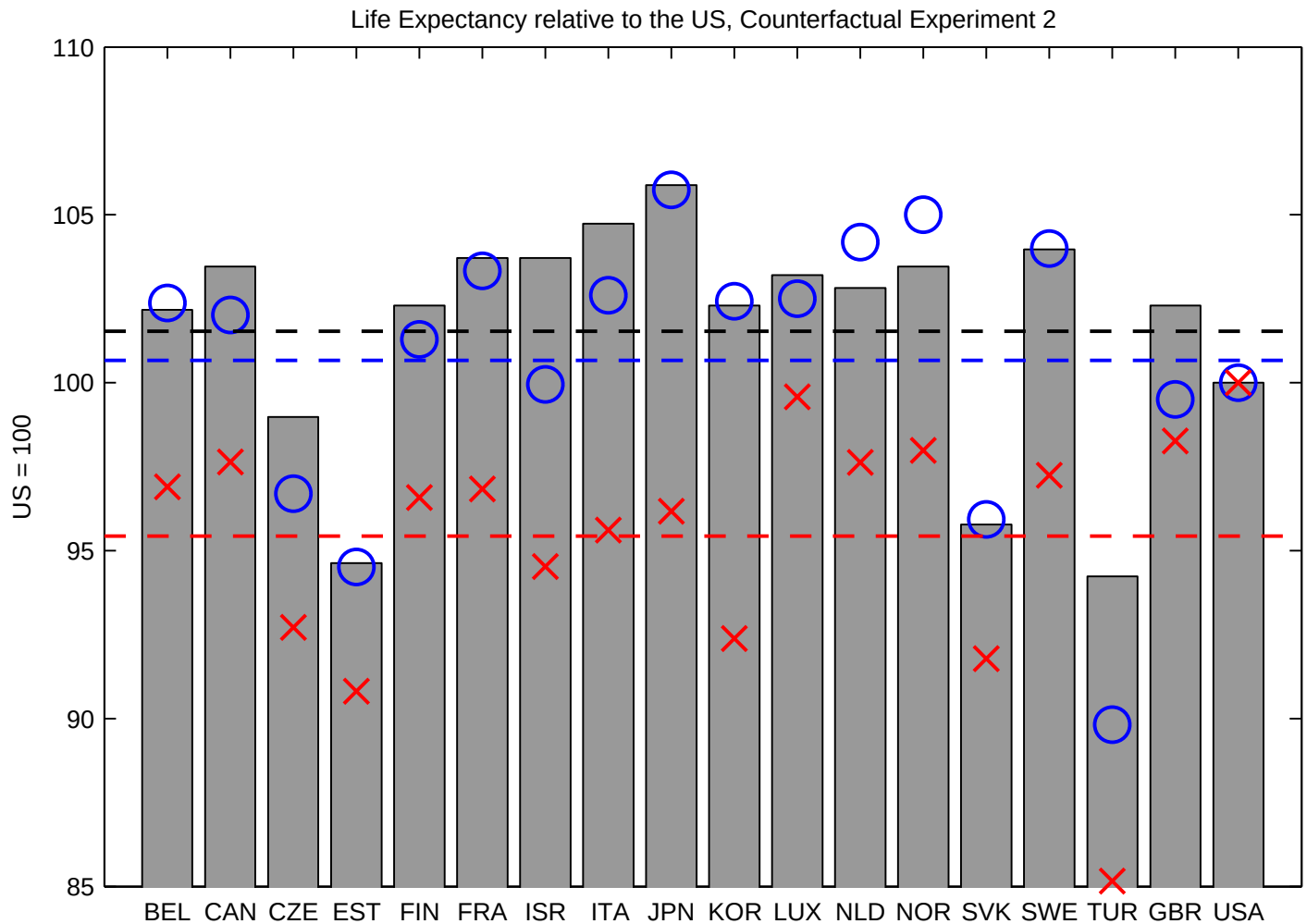
Experiment 2: Holding Obesity Rate at US level

Per Capita Health Care Spending, Relative to the US



Experiment 2: Holding Obesity Rate at US level

Life Expectancy at Birth, relative to the US (US = 100)



Results Summary

Per Capita Health Care Spending, relative to the US

Country	Data	Benchmark	Only Obesity Rate	Only GDP
Belgium	49	52	97	54
Canada	51	61	98	62
Czech Republic	24	22	98	22
Estonia	16	14	98	15
Finland	39	49	97	50
France	47	51	96	53
Israel	28	32	97	33
Italy	36	39	96	41
Japan	38	43	94	46
Korea	23	19	94	21
Luxembourg	49	90	98	92
Netherlands	57	60	96	62
Norway	58	64	96	67
Slovak Republic	23	18	98	18
Sweden	44	55	96	58
Turkey	10	4	97	4
UK	41	70	99	71
USA	100	100	100	100

Results Summary

Life Expectancy, relative to the US

Country	Data	Benchmark	Only Obesity Rate	Only GDP
Belgium	102	102	106	97
Canada	103	102	104	98
Czech Republic	99	97	104	93
Estonia	95	95	104	91
Finland	102	101	105	97
France	104	103	107	97
Israel	104	100	106	95
Italy	105	103	107	96
Japan	106	106	110	96
Korea	102	102	110	92
Luxembourg	103	103	103	100
Netherland	103	104	107	98
Norway	103	105	107	98
Slovak Republic	96	96	104	92
Sweden	104	104	107	97
Turkey	94	90	105	85
UK	102	100	101	98
USA	100	100	100	100

Extention to Life Cycle Model

Work in Progress

- We are using NLSY data to
  - Estimate mortality by age for obese and non-obese,
  - Probability of becoming obese at each age.
- We use MEPS data on spending and CDC mortality data to
  - Estimate parameters of the survival functions for each age group.
- Once we have these estimates we can run the full dynamic model.
- This work is in progress, but we don't have any results to report.

Conclusion

- Many important details on institutional arrangement missing from analysis.
- Large differences across countries with regard to those arrangements.
- We focus only on the differences in income
- We find the income differences have large effect.