Not everything that counts can be counted, and not everything that can be counted counts.

— Albert Einstein

Technology Capital and the US Current Account

Ellen R. McGrattan and Edward C. Prescott

June 2008

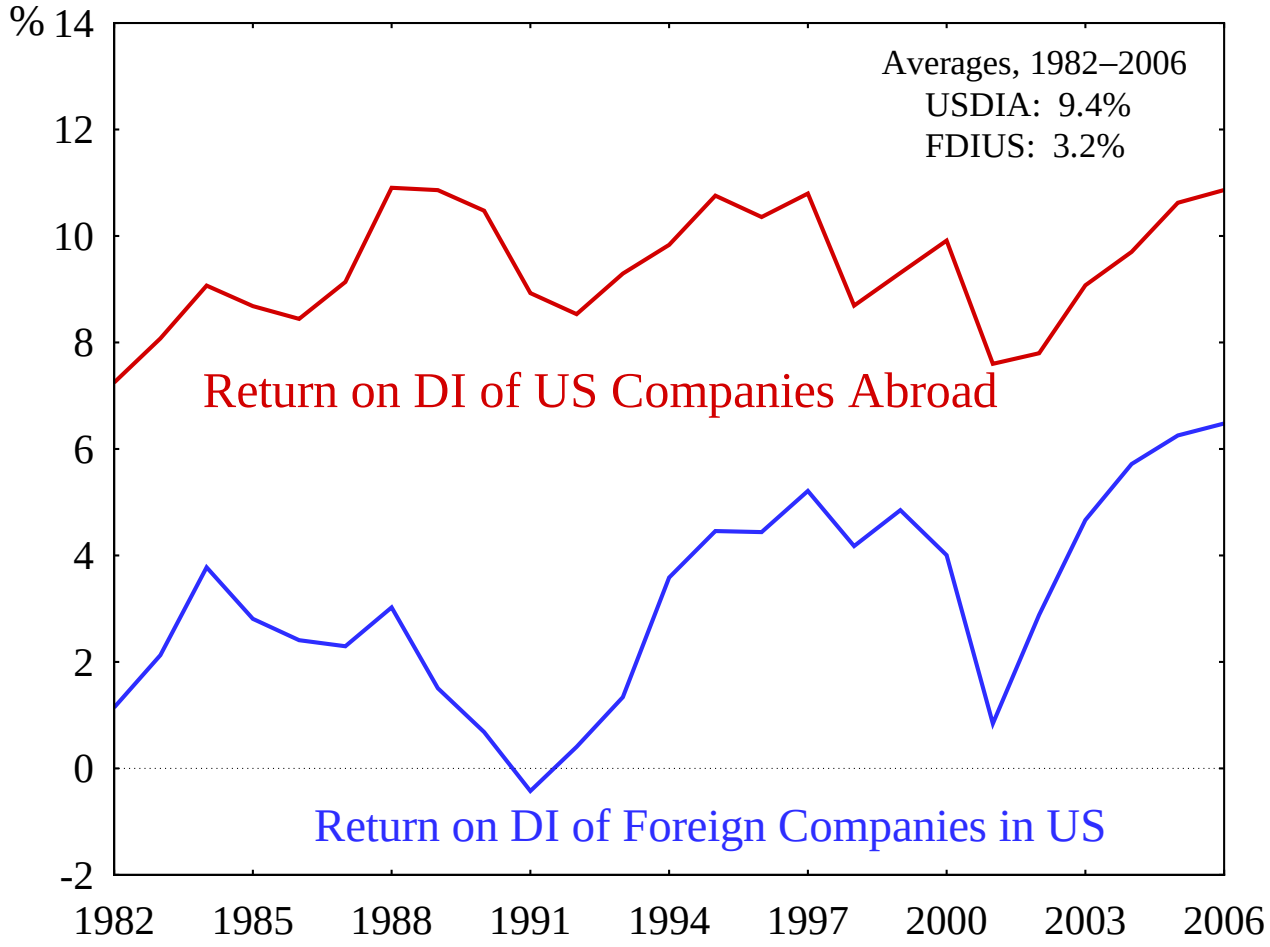
www.minneapolisfed.org/research /economists/emcgrattan.html

A Direct Investment (DI) Puzzle

- BEA reports for 1982–2006:
  - US companies earned 9.4% average returns
  - Foreign companies earned 3.2% average returns

on their foreign direct investment abroad

A Direct Investment (DI) Puzzle



Why is the return differential so large and persistent?

Our Answer has Two Parts

1. Measurement

2. Timing

Our Answer

1. Multinationals have large intangible capital stocks

2. Timing

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    - DI profits include intangible rents (+) and expenses (−)
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2. Different timing of DI by US and DI in US

   $\Rightarrow$ US and foreign reported returns not equal

Two Types of Intangible Capital

1. Intangible capital that is plant-specific

2. *Technology capital* that is not plant-specific

Technology Capital

- Is accumulated know-how from nvestments in
  - R&D
  - Brands
  - Organization know-how

which can be used in as many *locations* as firms choose

Reported FDI Return (r_{BEA})

- With no intangible capitals,

$$r_{BEA} =$$

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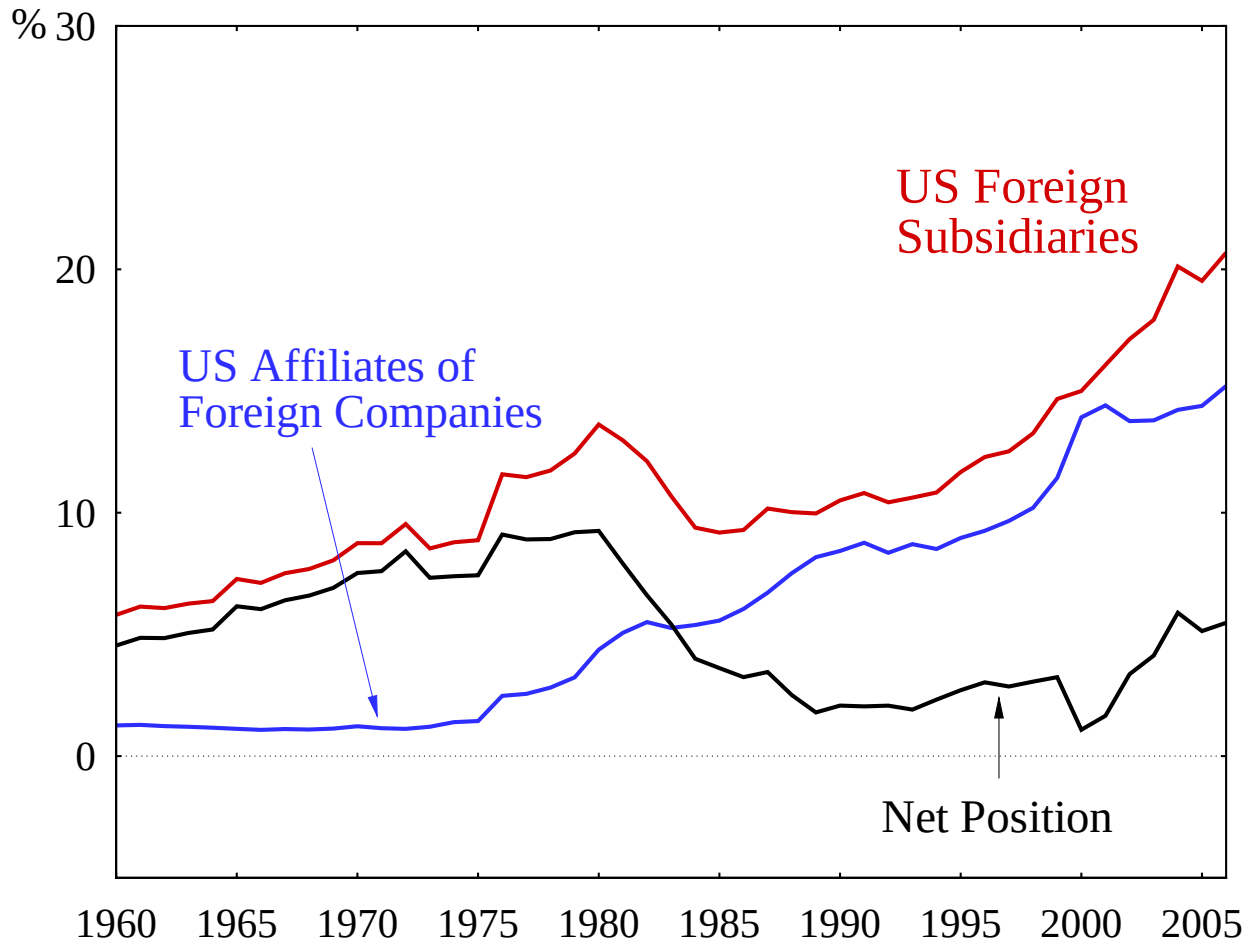
$$\neq r$$

Subsidiary Assets at Current Cost (% of US GNI)



FDI in US starts late, implying different timing of unmeasured investment and profits

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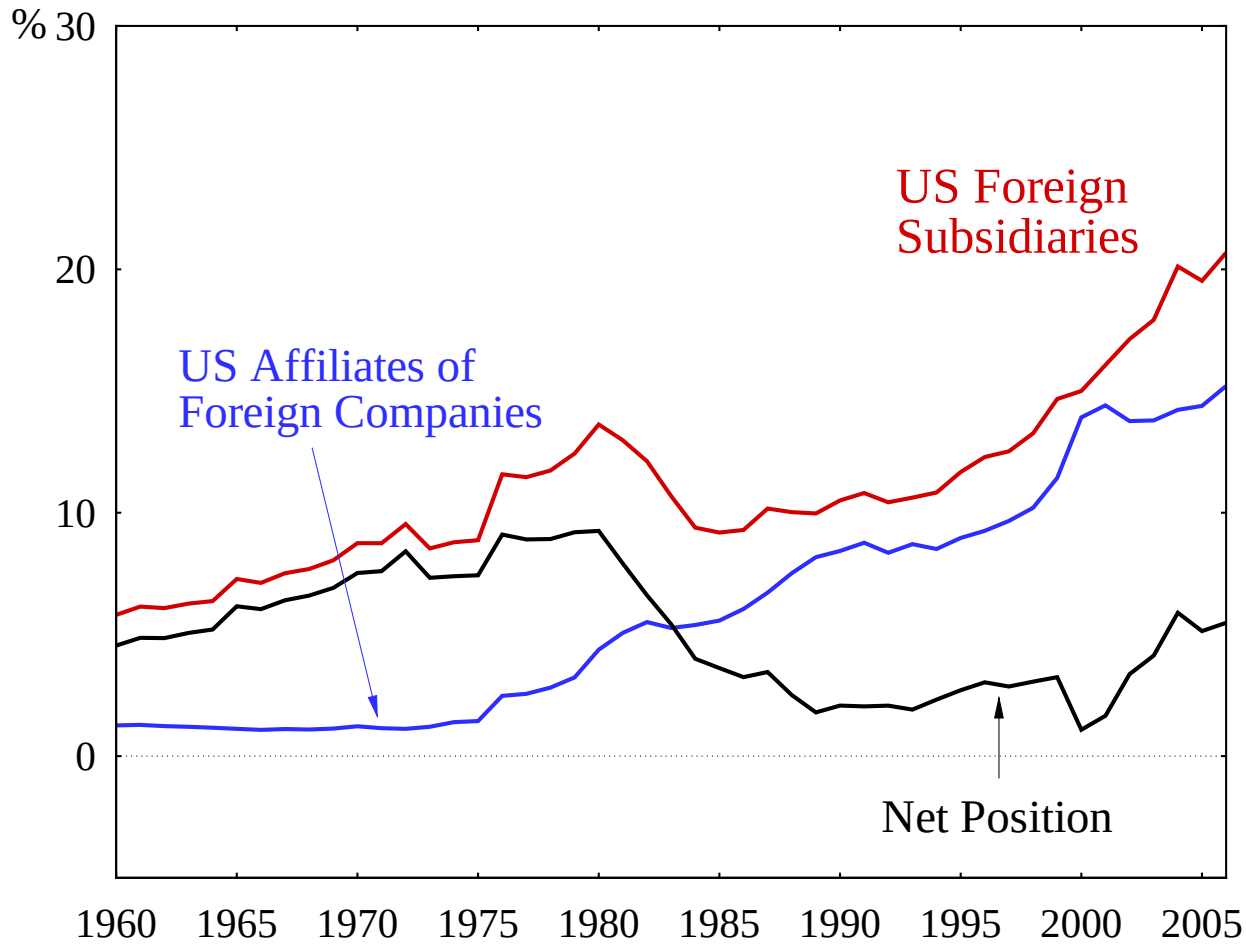

Policymakers are concerned about fall in net asset position

Findings

- Use model where each investment earns 4.6% on average

- We find average *BEA* returns on DI, 1982–2006:
  - of US = 7.1%
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- Also show: "net asset position" not a meaningful concept

Theory

Production in One-Country World

$$Y = A(NM)^{\phi} Z^{1-\phi}$$

M= units of *technology capital*

Z = composite of other factors

N= number of production *locations*

A= the technology parameter

ϕ= the income share parameter

which is the result of maximizing plant-level output

A Micro Foundation for Aggregate Function

- $n \in \{1, \ldots, N\}$, $m \in \{1, \ldots, M\}$

$$F(N, M, Z) = \max_{z_{nm}} \sum_{n,m} g(z_{nm})$$

$$\text{subject to} \quad \sum_{n,m} z_{nm} \leq Z$$

We assume $g(z) = Az^{1-\phi}$, increasing and strictly concave

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$\Rightarrow$ organizational span of control limits

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$\Rightarrow$ optimal to split Z evenly across location-technologies

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$$\Rightarrow F(N, M, Z) = NMg(Z/NM) = A(NM)^{\phi} Z^{1-\phi}$$

A Micro Foundation for Aggregate Function

- $n \in \{1, \ldots, N\}$, $m \in \{1, \ldots, M\}$

$$F(N, M, Z) = \max_{z_{nm}} \sum_{n,m} g(z_{nm})$$

$$\text{subject to} \quad \sum_{n,m} z_{nm} \leq Z$$

$$\Rightarrow F(N, \lambda M, \lambda Z) = \lambda F(N, M, Z)$$

Production in Multi-Country World

- The degree of openness of country i is $\sigma_i \in [0, 1]$

- Aggregate output in i is

$$\max_{z_d, z_f} \; M^i N_i A_i z_d^{1-\phi} + \sigma_i \sum\nolimits_{j \neq i} M^j N_i A_i z_f^{1-\phi}$$

$$\text{subject to} \quad M^i N_i z_d + \sum\nolimits_{j \neq i} M^j N_i z_f \leq Z_i$$

d, f indexes allocations to domestic and foreign operations

Production in Multi-Country World

- Aggregate output in i is

$$Y_i = A_i N_i^{\phi} (M^i + \omega_i \sum\nolimits_{j \neq i} M^j)^{\phi} Z_i^{1-\phi}$$

  where $\omega_i = \sigma_i^{\frac{1}{\phi}}$

- Alternative interpretation of openness: fraction of M^j let in

Production in Multi-Country World

- Aggregate output in i is

$$Y_i = A_i N_i^{\phi} (M^i + \omega_i \sum\nolimits_{j \neq i} M^j)^{\phi} Z_i^{1-\phi}$$

- Key result provided $\omega_i > 0$:

  Each i has constant returns, but summing over i results in a *bigger* aggregate production set.

Production in Multi-Country World

- Aggregate output in i is

$$Y_i = A_i N_i^{\phi} (M^i + \omega_i \sum\nolimits_{j \neq i} M^j)^{\phi} Z_i^{1-\phi}$$

- Key result:

  It is *as if* there were increasing returns,

  when in fact there are none.

Production in Multi-Country World

- Aggregate output in i is

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- Key result:

  We partially endogenize measured TFP since locations and technology capital affect measured TFP.

Implications of Adding Technology Capital

- If $\phi = 0$ in $Y_i = A_i(N_i[M^i + \omega_i \sum_j M^j])^{\phi}(Z_i)^{1-\phi}$

- If $\phi > 0$ and $\omega_i = 0$,

- If $\phi > 0$ and $\omega_i > 0$,

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- If $\phi = 0$ in $Y_i = A_i(N_i[M^i + \omega_i \sum_j M^j])^{\phi}(Z_i)^{1-\phi}$
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- If $\phi > 0$ and $\omega_i = 0$,
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  - More locations implies higher Y/N and Y/L
- If $\phi > 0$ and $\omega_i > 0$,
  - Foreign subsidiaries if ω_i not too small
  - More done by big (high A, N), closed (low ω) countries

Adding Labor and Other Capitals

- $Z_i^j = (K_{T,i}^j)^{\alpha_T}(K_{I,i}^j)^{\alpha_I}(L_i^j)^{1-\alpha_T-\alpha_I}$

  $K_{T,i}^j$ = *tangible* capital of companies from j in i

  $K_{I,i}^j$ = plant-specific *intangible* capital of j in i

  L_i^j = labor input to companies j in i

- With capital accumulation,

$$K_{T,i,t+1}^j = (1-\delta_T)K_{T,it}^j + X_{T,it}^j$$
$$K_{I,i,t+1}^j = (1-\delta_I)K_{I,it}^j + X_{I,it}^j$$
$$M_{t+1}^j = (1-\delta_M)M_t^j + X_{M,it}$$

A Decentralization to Match to BEA Accounts

Multinationals Incorporated in Country j Solve

$$\max \sum_t p_t(1-\tau_{d,t})D_t^j$$

given definition of dividends,

$$D_t^j + \underbrace{\sum\nolimits_i K^j_{T,i,t+1} - K^j_{T,it}}_{\textit{Reported}\text{ reinvested earnings}}$$

$$= \underbrace{\sum\nolimits_i \{(1-\tau_{p,it})(Y^j_{it} - W_{it}L^j_{it} - \delta_T K^j_{T,it} - X^j_{I,it} - \chi^j_i X^j_{M,t})}_{\textit{Reported}\text{ profits less expensed investments and taxes}}$$

where $\chi^i_i = 1$ and $\chi^j_i = 0$, $j \neq i$

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$\Rightarrow$ expensing done at home

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Key result: accounting profits are not equal to true profits

Households in i Solve

$$\max \sum_t \beta^t \, U\left(\frac{C_{it}}{N_{it}}, \frac{L_{it}}{N_{it}}\right) N_{it}$$

subject to budget constraint

$$\sum_t p_t\Big[(1+\tau_{c,it})C_{it}+\sum\nolimits_j V_t^j(S_{i,t+1}^j-S_{it}^j)+B_{i,t+1}-B_{it}\Big]$$

$$\leq \sum_t p_t\Big[(1-\tau_{l,it})W_{it}L_{it}+(1-\tau_{d,t})\sum\nolimits_j S_{it}^j D_t^j+r_{b,t}B_{it}+\kappa_{it}\Big]$$

$S_i^j =$ equity shares of companies from j

$B_i =$ foreign debt

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Note that measure of locations is proportional to population

$\Rightarrow$ same notation N

Using the Theory

- Two economies:
  - US
  - FDI-relevant ROW
    - Canada
    - Europe
    - Latin America
    - Part of Asia doing FDI with US
- Period is 1960–2006

Using the Theory

- Two economies:
  - US
  - FDI-relevant ROW

    Canada

    Europe

    Latin America

    Part of Asia doing FDI with US
- Period is 1960–2006
- Need data and model inputs

Data, 1960–2006

- US
  - Population
  - National income and product accounts
  - Flow of funds accounts
  - International accounts and investment positions
  - Internal revenue statistics of income
- ROW
  - Population
  - Total GDP

Model Constants (that don't matter)

- Trend growth rates

  $(\gamma_A = 1.2\%,\ \gamma_N = 1.0\%)$

- Preferences

  $(\beta = .98,\ u(c,l) = \log(c) + 1.32\log(1-l))$

- Fixed tax rates

  $(\tau_{li} = 29\%,\ \tau_{ci} = 7.3\%,\ \text{all } i)$

- Depreciation rates

  $(\delta_T = 6\%,\ \delta_M = 8\%)$

Model Constants (that do matter)

- Chose:
  - Technology capital income share: $\phi = 7\%$
  - Tangible capital income share: $(1-\phi)\alpha_T = 21.4\%$
  - Plant-specific intangible capital, joint choice of:

    Income share: $(1-\phi)\alpha_I = 6.5\%$

    Depreciation rate: $\delta_I = 0\%$
- So model generates:
  - Technology capital investment/GNP $\in$ [5.3%,6%]
  - Business tangible investment/GNP $\approx 11.3\%$
  - Business total value/GNP ≈ 1.5 in 1960s

Initial Business Capital Stocks

- Consistent with
  - US GDP, 1960 = 1
  - ROW GDP, 1960 = 2.2
  - No initial jumps in investment $\left(\frac{\dot{X}^j_{\cdot,i1}}{X^j_{\cdot,i1}} = \frac{\dot{X}^j_{\cdot,i2}}{X^j_{\cdot,i2}}\right)$

$$\Rightarrow K_{T,u,1960} = 1.30, \quad K_{I,u,1960} = 1.17, \quad M^u_{1960} = 0.52$$

Time-Varying Inputs

- Tax rates on capital
- Portfolio composition
- Paths of openness and relative size

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Time-Varying Inputs

- Tax rates on capital: smoothed US rates
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- Paths of openness and relative size to match:
  - US DI income from abroad
  - Foreign DI income in US
  - US trade balance

  trends in US current accounts (Size=$N_i A_i^{1-(1-\phi)(\alpha_T+\alpha_I)}$)

To Match, Need US Initially Less Open

- 4 reasons why this is reasonable:

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1. Overvalued dollar under Bretton Woods System

> "Currency undervaluation acted as a strong disincentive to FDI in the US, both because it placed an artificially high price on dollar-denominated assets, and because it gave foreign producers an inherent cost advantage in selling in U.S. markets through exports."
>
> — 1976 Report of Commerce Secretary on FDI

To Match, Need US Initially Less Open

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1. Overvalued dollar under Bretton Woods System

Between 1971 and 1973 the dollar depreciated

35% relative to the German mark

26% relative to the Japanese yen

27% relative to the French franc

28% relative to the Dutch guilder

35% relative to the Swiss franc

To Match, Need US Initially Less Open

- 4 reasons why this is reasonable:
  1. Overvalued dollar under Bretton Woods System
  2. High cost of financing with Interest Equalization Tax
     - Starting 1963,

       15% tax on interest from foreign borrowing

       $\Rightarrow$ US capital markets effectively closed
     - Removed in 1974

To Match, Need US Initially Less Open

- 4 reasons why this is reasonable:
  1. Overvalued dollar under Bretton Woods System
  2. High cost of financing with Interest Equalization Tax
  3. Extraterritorial application of US regulations
     - Especially, antitrust laws
     - Some governments made it illegal to comply

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- 4 reasons why this is reasonable:

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  2. High cost of financing with Interest Equalization Tax
  3. Extraterritorial application of US regulations
  4. National security concerns used to block FDI

     - Trading with the Enemy Act, 1917

       $\Rightarrow$ broad powers to block or seize FDI

     - Amended in 1976

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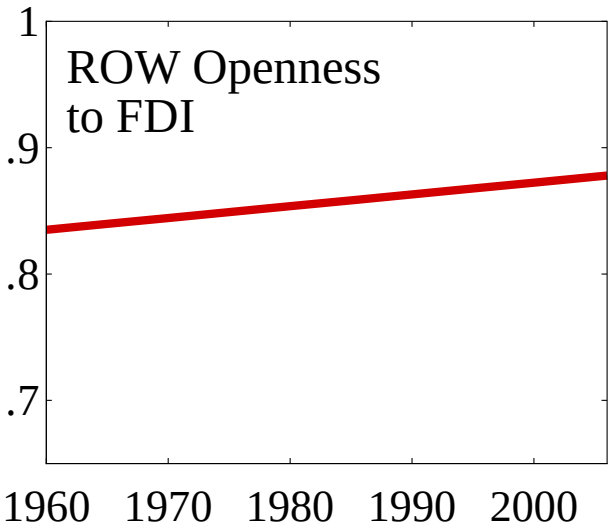
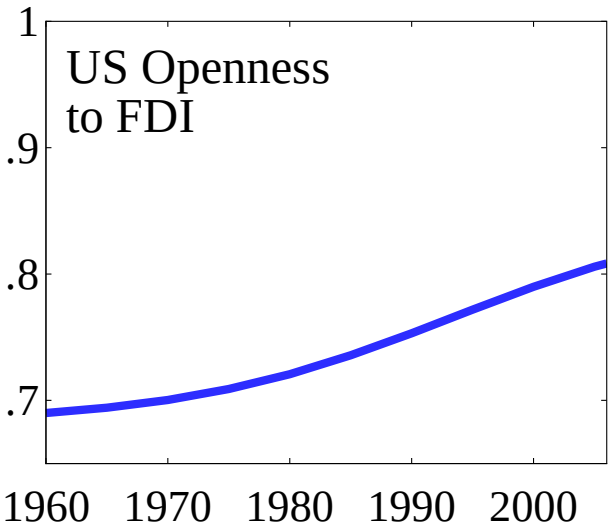
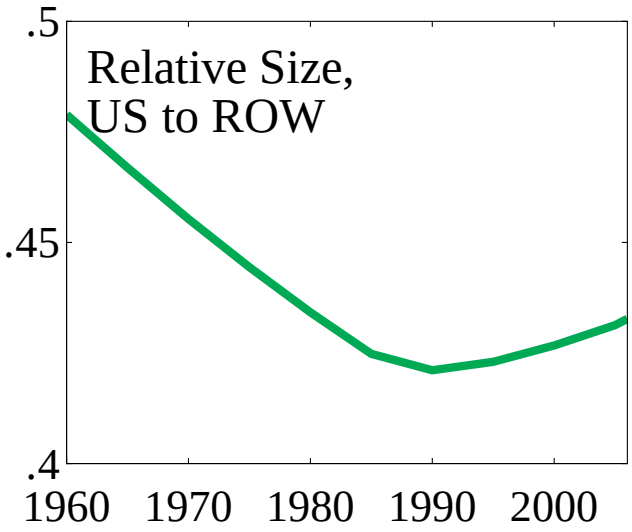
- Next, consider the inputs we use

Openness and Relative Size







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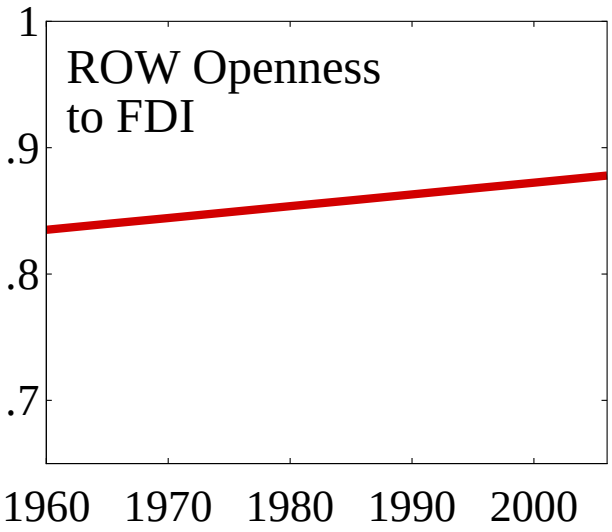
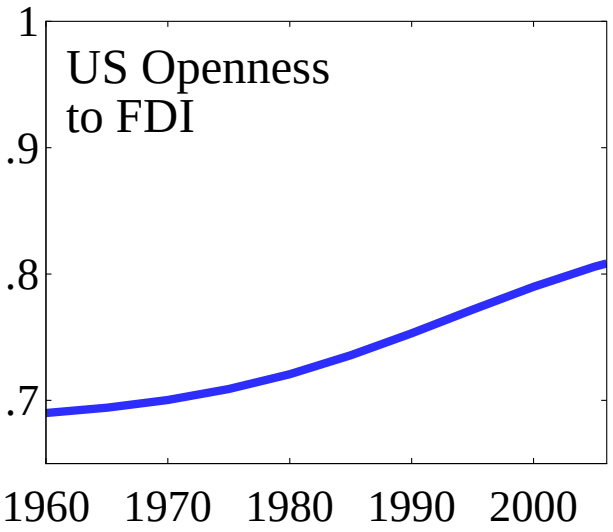
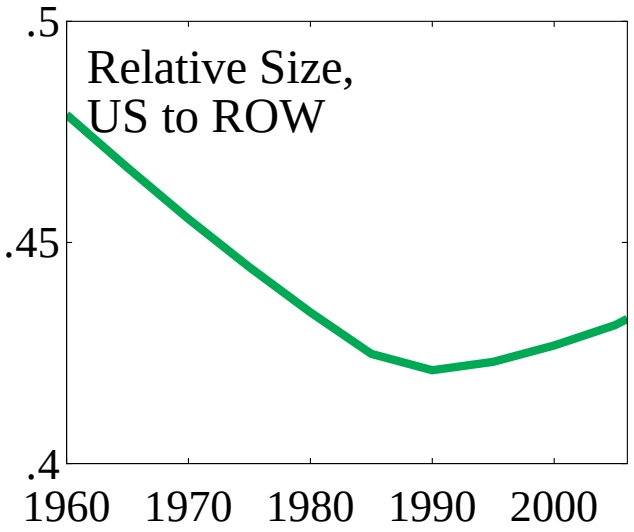
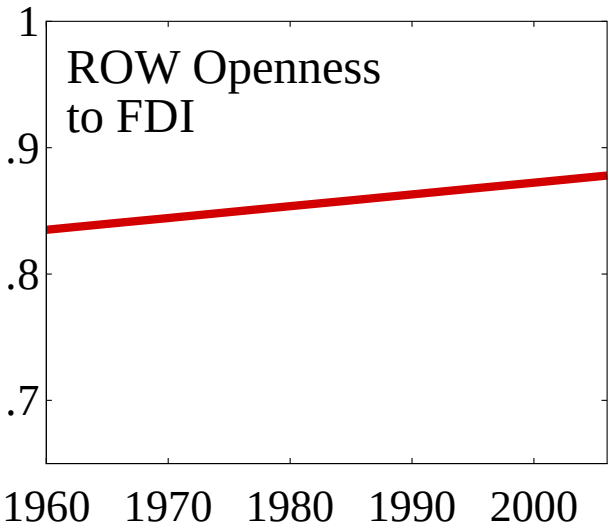


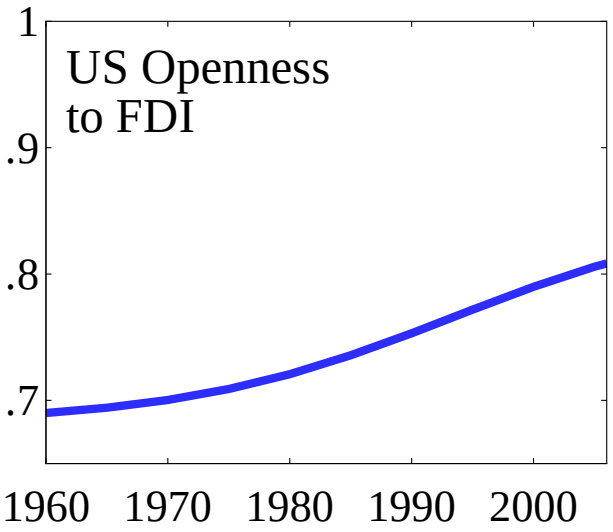


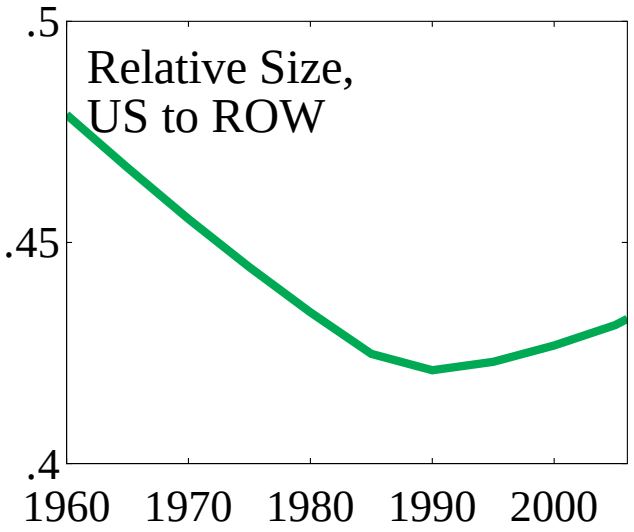


Note that ROW is more open than US....

Openness and Relative Size

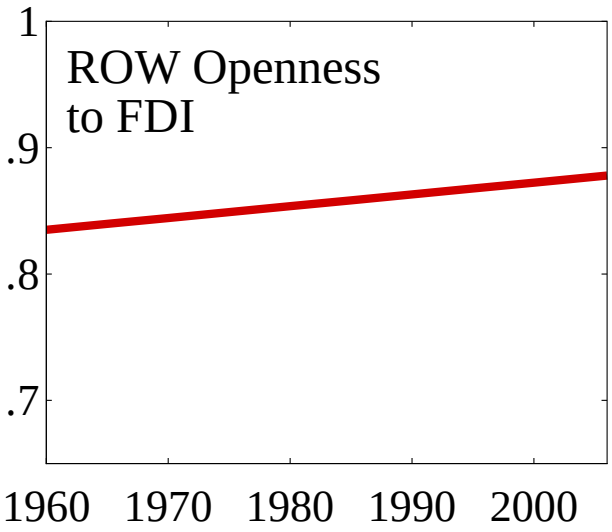


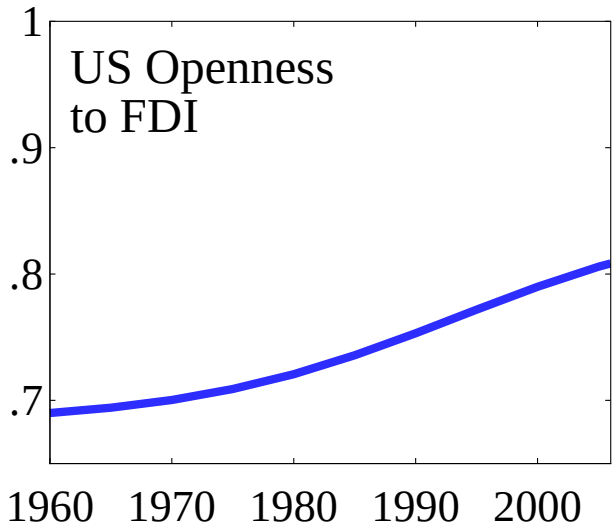


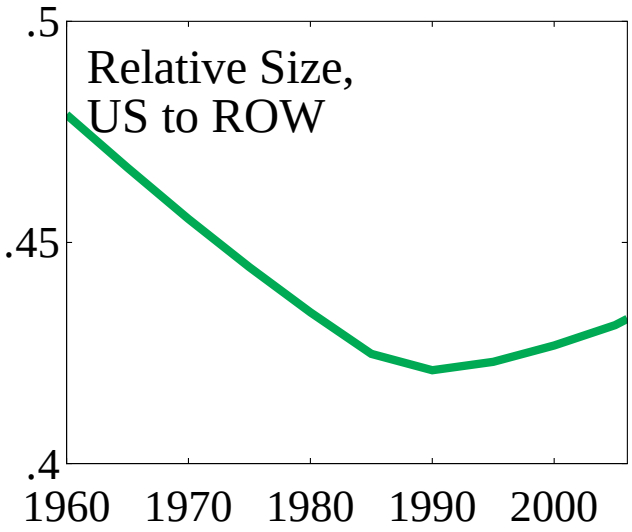


Also note fall in size ....

Openness and Relative Size



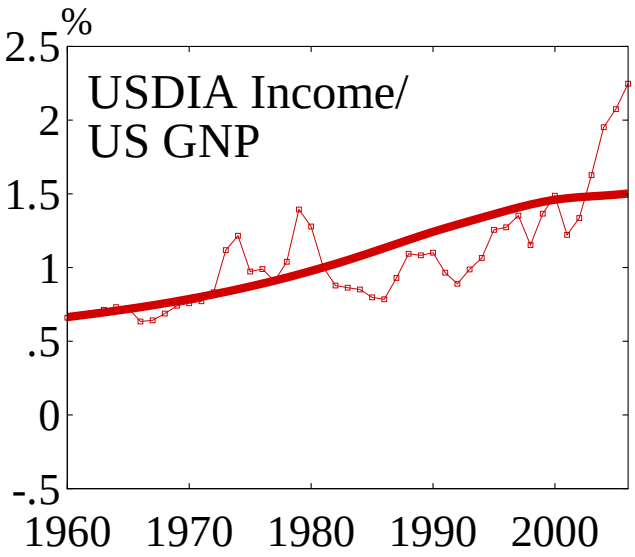


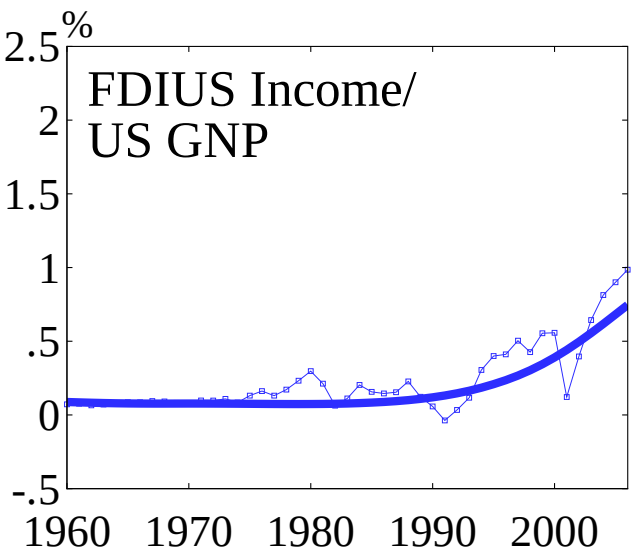


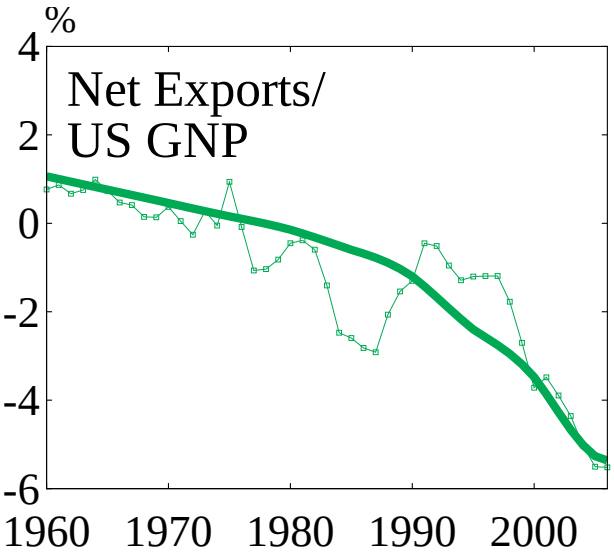
Also note fall in size ... due mostly to relative populations

Predictions

Predicted FDI Incomes and Trade Balance





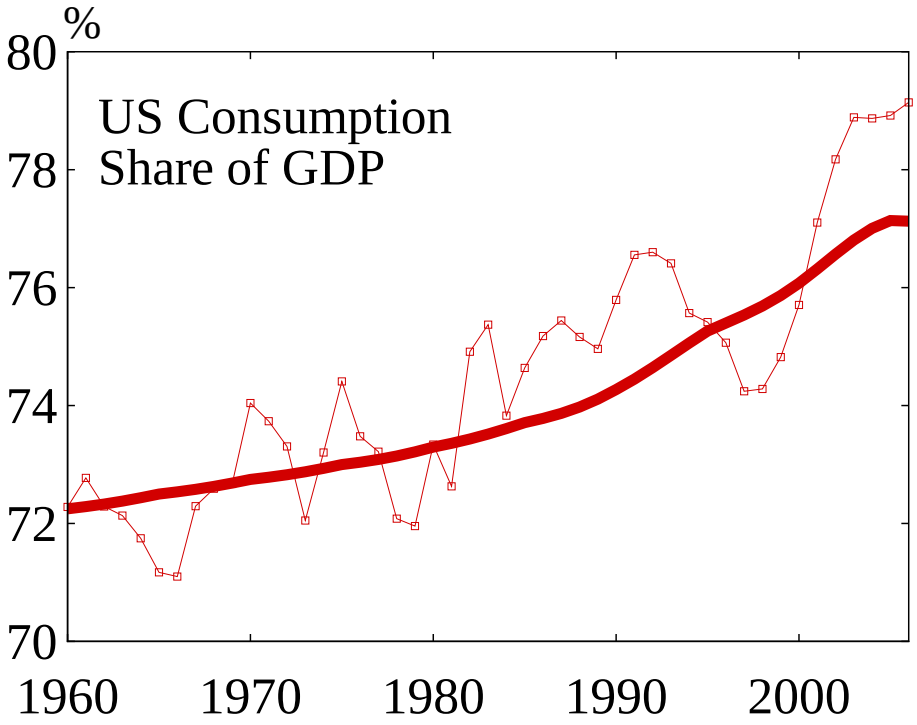


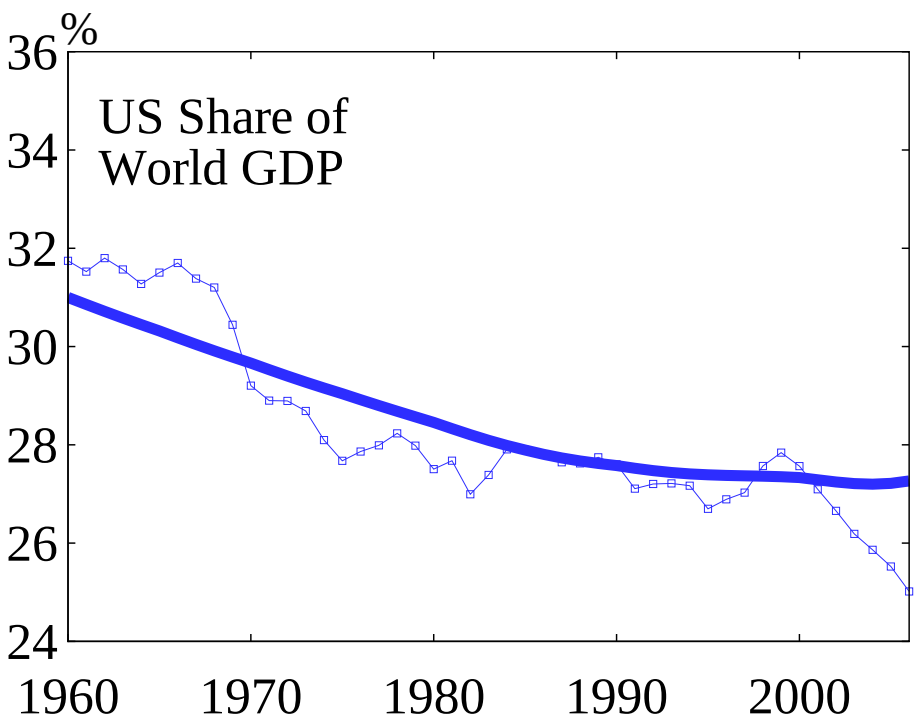
Model

Data

External Conformity

Are Other Trends Consistent?

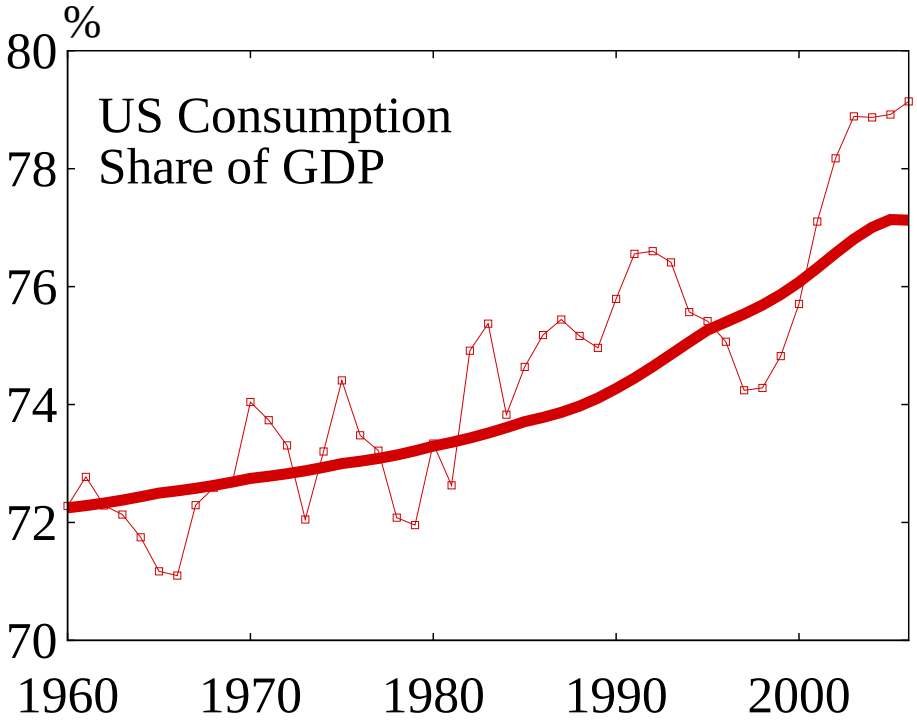


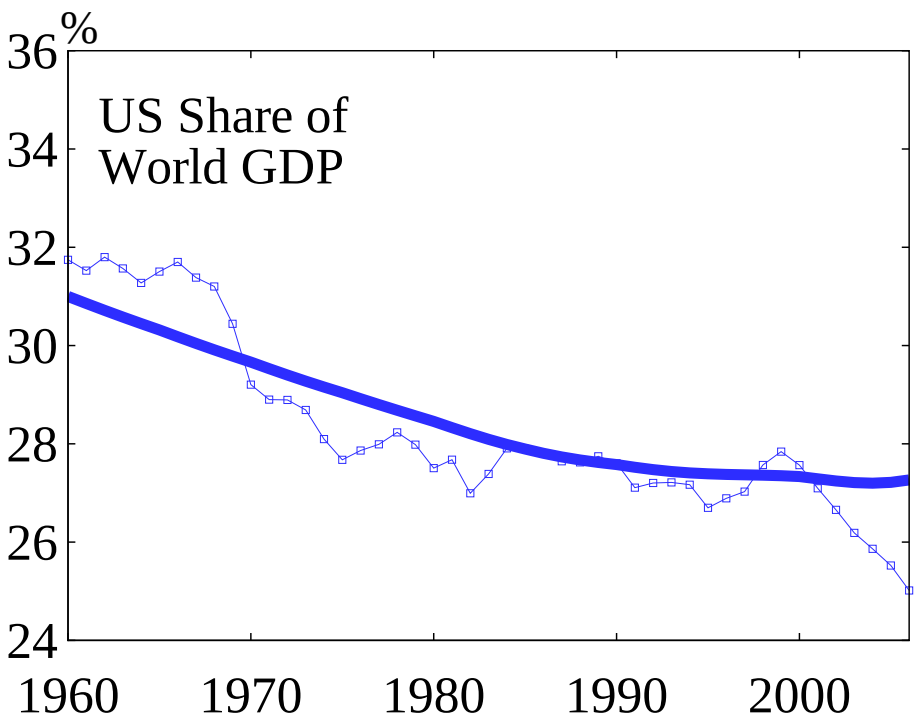


Model

Data

Are Other Trends Consistent? Yes



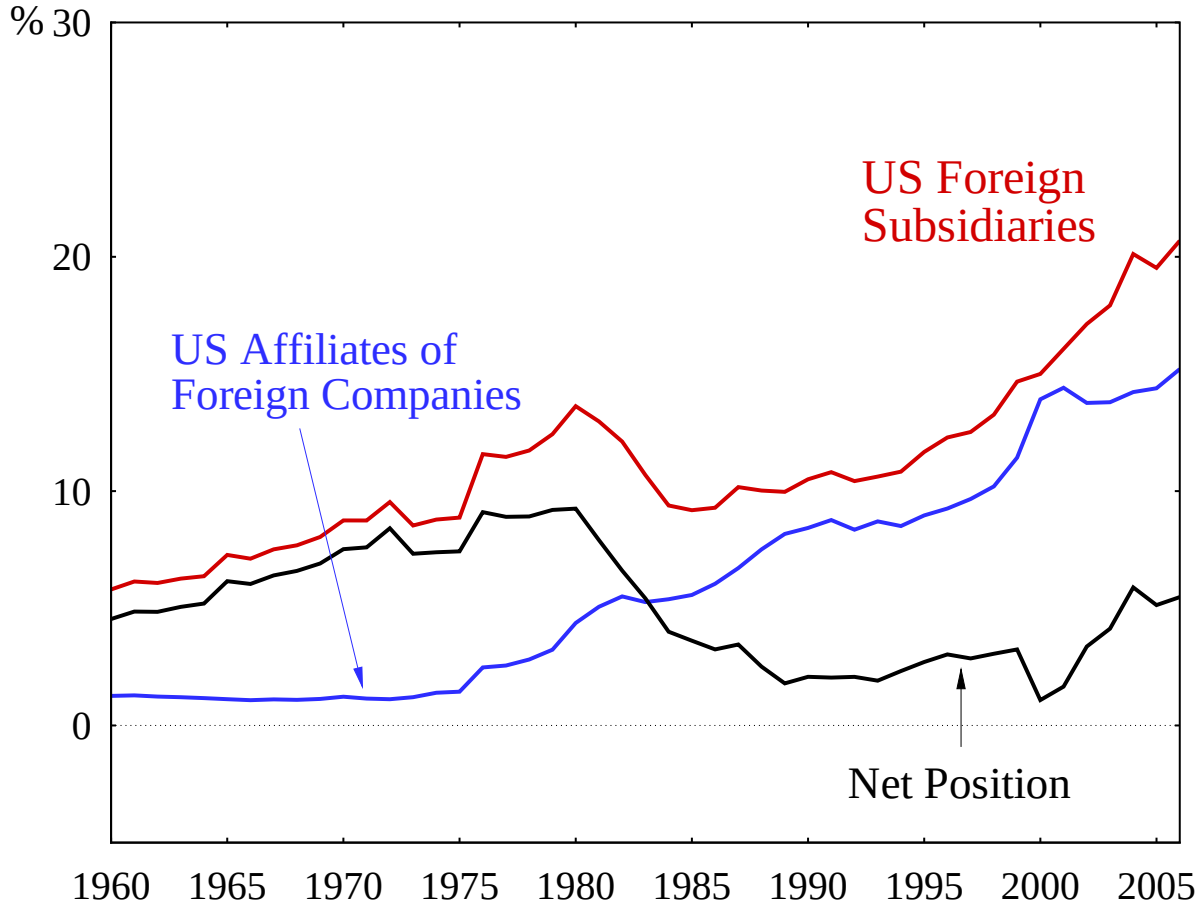


Model

Data

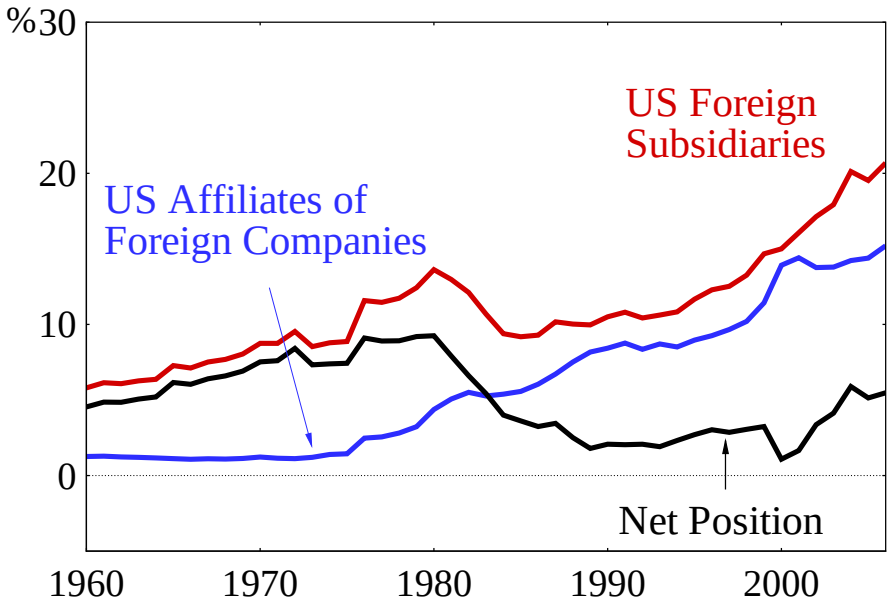
Using the Theory to Predict FDI Stocks and Returns

Recall: FDI Stocks at Current Cost

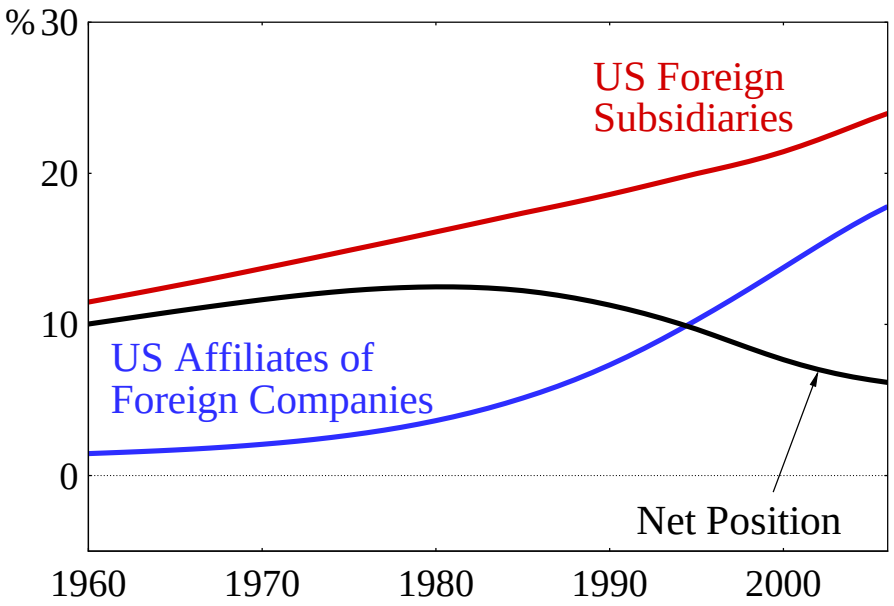


FDI net income rising while net position falling

BEA Stocks—Data and Model



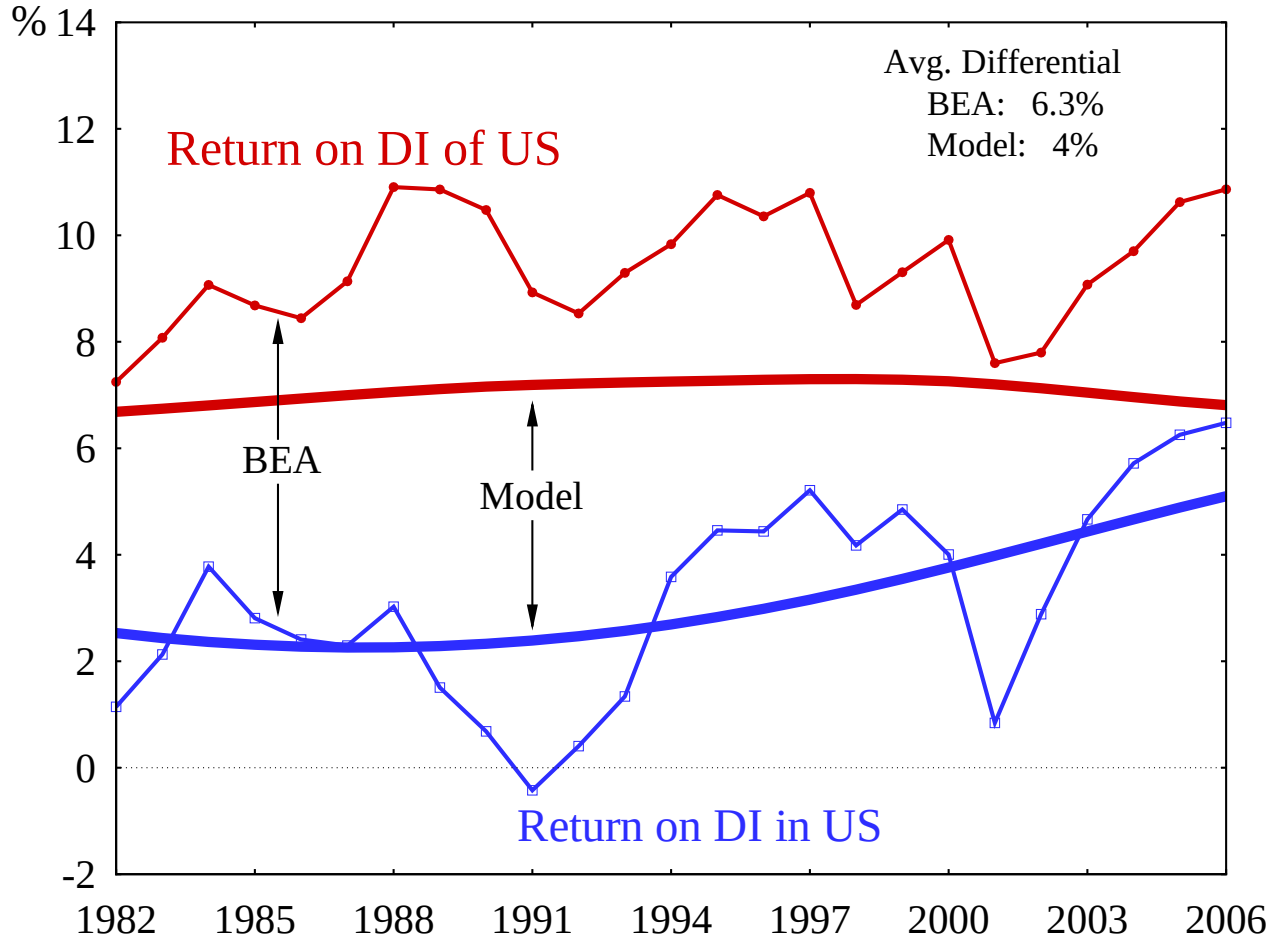
BEA



Model

FDI net income rising while net position falling ... as observed

BEA Returns—Data and Model



Account for over 60% of difference in return

Why Model Generates Different Reported Returns

- Differences primarily due to:
  - Big rents on tech. capital: BEA overstates return
  - Big expensed investments: BEA understates return

with latter especially important for US affiliates

Importance of Openness Paths

	1960s	Averages, 1960-2006			
	$\frac{V_t^u}{GNP_{ut}}$	$\frac{M_t^u}{GNP_{ut}}$	$\frac{\sum_j K_{I,ut}^j}{GNP_{ut}}$	$\frac{K_{I,it}^j}{K_{T,it}^j}$	Return Gap
Benchmark:	1.51	0.53	1.20	0.91	3.96
Alternative:					
$\sigma_{it} = \sigma_{i,1960}$	1.47	0.52	1.19	0.90	$-.03$

$\Rightarrow$ if countries stayed at 1960s openness level,

predicted gap is roughly zero

Sensitivity

- What would model predict if parameters governing size of intangibles different

  1. Openness and size adjusted to fit US current account

  2. Didn't fit stock market and technology capital values

Sensitivity: Technology Capital Depreciation

	1960s	Averages, 1960-2006			
	$\frac{V_t^u}{GNP_{ut}}$	$\frac{M_t^u}{GNP_{ut}}$	$\frac{\sum_j K_{I,ut}^j}{GNP_{ut}}$	$\frac{K_{I,it}^j}{K_{T,it}^j}$	Return Gap
Benchmark:					
$\delta_M = 8\%$	1.51	0.53	1.20	0.91	3.96
Alternatives:					
$\delta_M = 0\%$	1.82	1.39	1.20	0.91	3.91
$\delta_M = 16\%$	1.45	0.37	1.20	0.91	3.97

$\Rightarrow \delta_M$ has big effect on V and M but small on return gap

Sensitivity: Technology Capital Share

	1960s	Averages, 1960-2006			
	$\frac{V_t^u}{GNP_{ut}}$	$\frac{M_t^u}{GNP_{ut}}$	$\frac{\sum_j K_{I,ut}^j}{GNP_{ut}}$	$\frac{K_{I,it}^j}{K_{T,it}^j}$	Return Gap
Benchmark:					
$\phi = 7\%$	1.51	0.53	1.20	0.91	3.96
Alternatives:					
$\phi = 8\%$	1.49	0.61	1.17	0.90	3.85
$\phi = 6\%$	1.61	0.47	1.34	0.96	4.26

$\Rightarrow$ ϕ larger implies smaller gap because K_I less important

Sensitivity: Intangible Capital Depreciation and Share

	1960s	Averages, 1960-2006			
	$\frac{V_t^u}{GNP_{ut}}$	$\frac{M_t^u}{GNP_{ut}}$	$\frac{\sum_j K_{I,ut}^j}{GNP_{ut}}$	$\frac{K_{I,it}^j}{K_{T,it}^j}$	Return Gap
Benchmark:					
$\delta_I = 0\%$, $\alpha_I = 7\%$	1.51	0.53	1.20	0.91	3.96
Alternatives:					
$\delta_I = 6\%$, $\alpha_I = 7\%$	1.47	0.59	0.60	0.39	2.70
$\delta_I = 0\%$, $\alpha_I = 10\%$	1.56	0.52	1.54	1.22	4.51

$\Rightarrow$ δ_I, α_I together determine size of K_I, which is key for gap

But even if K_I cut in half, predicted gap still sizable

What Might Account for Remaining 2.3%?

- Some think:
  - Transfer pricing to avoid high US taxes
  - Risk premium for projects abroad; discount in US
- Most likely:
  - US more efficient in producing technology capital

What Might Account for Remaining 2.3%?

- Some think:
  - Transfer pricing to avoid high US taxes
  - Risk premium for projects abroad; discount in US
- Most likely:
  - US more efficient in producing technology capital
- Challenge: model with added factor must fit US data

US Net Asset Position

- Not a meaningful concept given technology capital
  - What are the domestic assets?
  - What are the foreign assets?

Conclusions

- BEA reports show:
  - Returns of DI abroad much higher than DI in US
  - US net direct investment position falling
- Want some resolution to avoid unnecessary bad policy
- We resolve large part using model with
  - Technology capital
  - Plant-specific intangible capital