Firm Dynamics and Immigration: The Case of High-Skilled Immigration

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Big Picture...

How does immigration affect relative wages, output, and welfare?

How are the gains (or losses) from changes in policy accrued over time?

This Paper...

Dynamic, heterogenous firm, monopolistic competition model + complementarity between firms' productivity and skill type of workers.

- Endogenous exit and entry $\Rightarrow$ nontrivial transition dynamics.
- Skill/productivity complementarity $\Rightarrow$ nontrivial wage dynamics.

Calibrate the model and compute the transition path for the US economy associated with a change in immigration policy.

Focus on two polices:

- A "neo-liberal" policy: Immigration Innovation Act Of 2015 (an expansion of the H-1B visa program).
- A "nationalistic" policy: eliminate the H-1B visa program.

The Context...

My take on the immigration literature...

Largely focused on measuring relative wage impact. Change in relative wages stand in for the normative implications. **VERY** controversial...

- Immigration has small affects on relative wages, e.g., Card (2009).
- Immigration has large affects on relative wages, e.g., Borjas (2003).

My paper adds a new dimension (the firm) and speaks to these issues...

- Dynamics complicate the interpretation of these measurement exercises.

  Firm dynamics + immigration $\Rightarrow$ short-run wage responses $\neq$ long-run.

- Dynamics enrich the normative implications.

  Neo-liberal policy: Wages and output increase in the short- and long-run; consumption falls in short-run, but larger in the long-run.

And illustrates these points by answering a policy relevant question.

Model: Consumers

Discrete time, infinite horizon economy.

Consumers with utility:

$$\sum_{t=0}^{\infty} \beta C_t$$

$$C_t = \left[\int_{M(t)} c_t(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}}$$

- $M(t) =$ varieties consumed.
- $\sigma =$ elasticity of substitution across varieties.

Consumers inelastically supply labor units.

Model: Workers

Two types of workers:

- L_u mass of low-skilled workers.
  Empirical analog: those with less than college.

- L_s mass of high-skilled workers.
  Empirical analog: college or more.

Each type supplies their labor in a perfectly competitive labor market.

Immigrants and permanent residents are the same.

Model: Firms

Large pool of monopolistically competitive firms.

Firms are...

- Heterogeneous over productivity, z. Evolves stochastically according to a N-state Markov chain with transition matrix $\mathcal{P}$.
- Have CES production technologies using high and low-skill labor.
- Incumbents: Face per-period fixed cost, κ, to operate next period.
- Potential entrants: Face one-time entry costs, κ_e, to enter the market.

Model: Firms' Production Technology

A firm producing variety ω has the following technology:

$$q(\omega) = z\left[\phi_s(z)\ell_s^{\frac{\theta-1}{\theta}} + \phi_u\ell_u^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}},$$

z is productivity; θ is the elasticity of substitution between labor types.
ϕs are the skill weights.

- Non-standard feature: the ϕs may vary with firm productivity.
- If $\phi_s'(z) > 0$ then skilled workers are more productive in high productivity firms; high-productivity firms demand relatively more skilled workers.
- Data will discipline this force.
- Very similar to Burstein and Vogel (2016).

Overview of Optimization Problems

Incumbent firms: produce and stay, or exit. . .

Choose price and labor units (and skill mix) to maximize operating profits $\pi(z)$.

Choose to operate next period or exit.

- Pay fixed operating cost κ to stay.
- Otherwise, receive $\pi(z)$ and then cease operation.

Entrant firms. . .

Receive initial productivity from density $\mathcal{P}_e(z)$ at cost κ_e.

- Given initial productivity, just like an incumbent: produce and stay, or exit.

Consumers (and workers). . .

Receive labor income and profits from firms. Purchase varieties and consume.

Firm's Optimization Problem

Abstracting from aggregate states, the value function of an incumbent firm is:

$$v(z_i) = \max \left[\pi(z_i) - \kappa + \beta \sum_{j=1}^{N} \mathcal{P}(i,j) v(z_j) \quad , \quad \pi(z_i) \right].$$

The value of entry is:

$$v^e = \sum_{j=1}^{N} \mathcal{P}_e(j) v(z_j) - \kappa^e.$$

Plan of Attack

The analytics of the aggregate skill premium.

Quantitative exercise: evaluate a change in immigration policy.

1. Measuring the effect of the policy change on the stock of labor.
2. Calibrate the model to match data on US firms.
3. The dynamic response to a change in high-skilled immigration.
   - A "neo-liberal" policy: Immigration Innovation Act Of 2015 (an expansion of the H-1B program).
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The Aggregate Skill Premium

The Aggregate Skill Premium: Log relative wages relate to aggregate, log relative skill supplies

$$\log(w_s) - \log(w_u) = -\frac{1}{\theta}\Theta(w_s, w_u, \mu) - \frac{1}{\theta}\left[\, \log(L_s) - \log(L_u) \,\right],$$

where

$$\Theta(w_s, w_u, \mu) = \log\left\{\sum_i \frac{\phi_s(z_i)^\theta \;\mu(z_i)\ell(z_i)}{\phi_s(z_i)^\theta w_s^{-\theta} + \phi_u^\theta w_u^{-\theta}}\right\} - \log\left\{\sum_i \frac{\phi_u^\theta \;\mu(z_i)\ell(z_i)}{\phi_s(z_i)^\theta w_s^{-\theta} + \phi_u^\theta w_u^{-\theta}}\right\}$$

Furthermore, the change with respect to a change in relative skill supply is

$$d\log(w_s) - d\log(w_u) = d\Theta - \frac{1}{\theta}\left[\, d\log(L_s) - d\log(L_u) \,\right].$$

Three observations. . .

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Three observations. . .

1. Very similar to the CES structure used in the immigration literature (e.g. Card (2009)). But note how the firm distribution (i.e. the μs) show up in Θ.

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where

$$\Theta = \log(\phi_s) - \log(\phi_u)$$

Furthermore, the change with respect to a change in relative skill supply is

$$d\log(w_s) - d\log(w_u) = -\frac{1}{\theta}\left[\, d\log(L_s) - d\log(L_u) \,\right].$$

Three observations. . .

2. How is it different? It's because of the complimentarily between skill and productivity. With ϕ_s independent of z, it's the "standard" case.

The Aggregate Skill Premium

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$$\log(w_s) - \log(w_u) = -\frac{1}{\theta}\Theta(w_s, w_u, \mu) - \frac{1}{\theta}\left[\, \log(L_s) - \log(L_u) \,\right],$$

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Three observations. . .

3. Thus, firm dynamics only matter for the dynamics of relative wages when there is interaction between skill and productivity.

Plan of Attack

The analytics of the aggregate skill premium.

Quantitative exercise: evaluate a change in immigration policy.

1. **Calibrate the model to match data on US firms.**
2. Measuring the effect of the policy change on the stock of labor.
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Parametrization of Productivity and Skill Weights

Firm productivity shocks (in logs) follow an AR(1) process

$$\log z_{t+1} = \rho \log z_t + \epsilon_{t+1} \quad \text{with} \quad \epsilon_{t+1} \sim \mathcal{N}(0, \sigma_z).$$

New entrants receive a initial productivity level which is a mean shift μ_e of the invariant distribution described associated with process above.

The skill-weights in the production function (ϕs): Normalize ϕ_u to one. Assume that

$$\phi_s(z) = \alpha z^{\gamma},$$

where γ controls the sign and magnitude of the complementarity.

Calibration

Calibration Summary

Parameter	Value	Source or Target
Predetermined Parameters		
Discount Rate, β	0.98	—
Demand Elasticity σ	4.0	—
Skill Elasticity θ	**3.0**	—
Entry Cost, κ_e	1.0	Normalization
Calibrated Parameters		
ρ	0.90	Autocorrelation of size, Synthetic LBD
σ_z	0.20	Ratio of median size to mean $\approx$ 25
κ	0.14	Entry Rate of 10 percent
μ_e	**-0.13**	Probability of survival of entrants after 5 years, 0.50
α	0.57	Skill Premium, 1.90
γ	**1.00**	Size-Wage Premium, 1.30

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Current US Policy and the I-Squared Act

Current US high-skilled immigration policy

- A maximum of (private sector) 65,000 H-1B visas per year. Additional 20,000 visas for advanced degree recipients from US institutions.
- Thus, current policy allows up to 85,000 visas per year.
- Maximum duration of H-1B visa is six years.

Measuring the Change in the Stock of High-Skilled Labor

1. The stock of high-skilled labor with permanent status evolves:

$$L^p_{s,t+1} = (1-\delta)L^p_{s,t} + \text{new graduates}_t + \text{H-1B transitions}_t,$$

The total stock of the skilled labor force is

$$L_{s,t} = L^p_{s,t} + \text{ stock of H-1B Visas}_t.$$

2. Use estimates of H-1B visa transitions and the stock...

- Lowell (2000) estimates a stock of 510,000 visa holders; About 50 percent of expiring visa holders transition into permanent status per year.

And solve for δ such that the stock of high-skilled labor is stationary.

3. Project forward the stock of high-skilled labor under the new policy.

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Policy Experiment: Increase High-Skilled Immigration

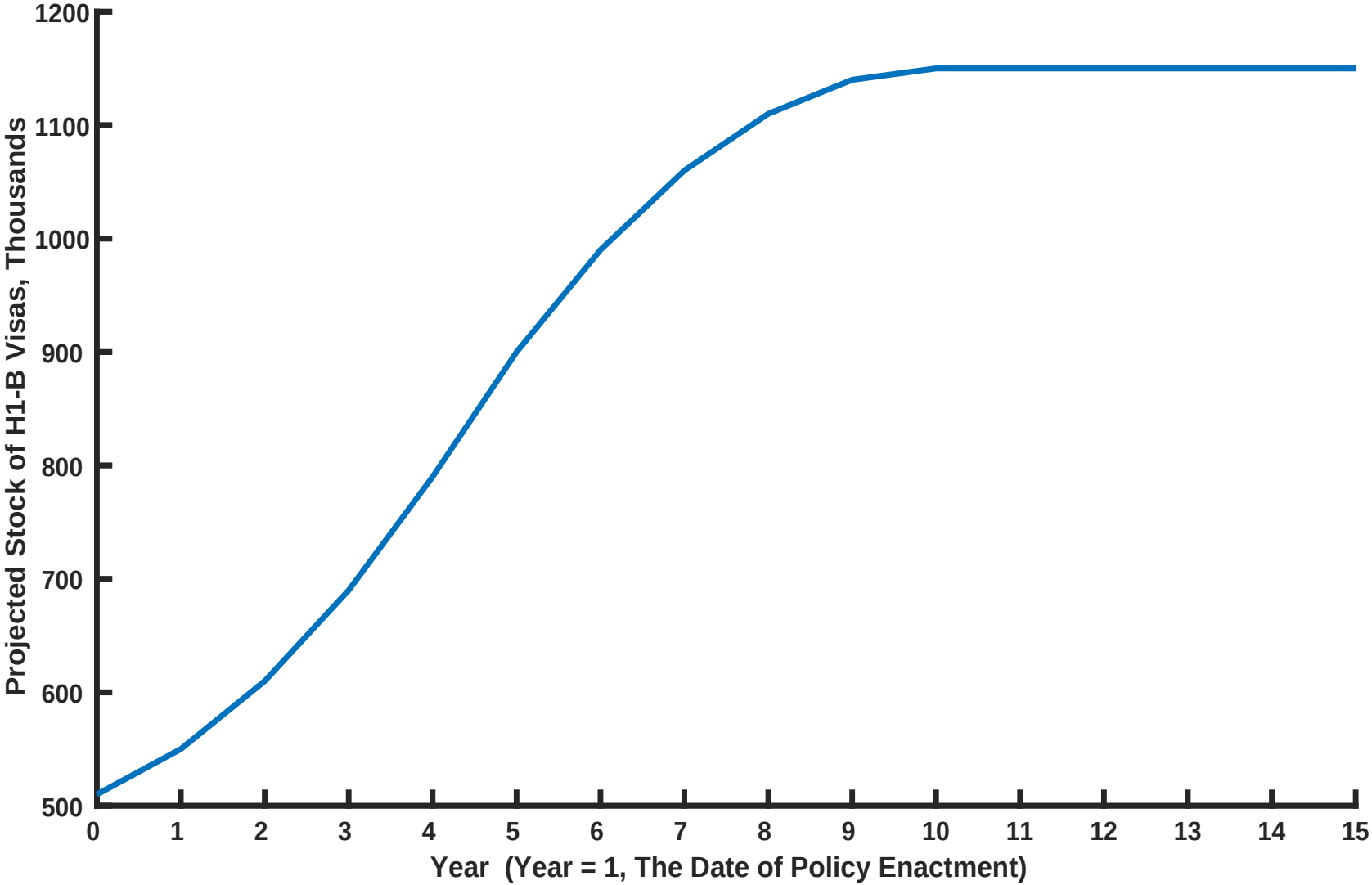
Implement the Immigration Innovation Act Of 2015 or "I-Squared" policy...

- The I-Squared Act raises the cap to 195,000 visas per year, eliminates the advanced degree exception.
- Contains "escalators" that restrict the increase by 20,000 visas per year until reaching the cap.
- Treat the change in policy as unanticipated. Compute the transition of the economy given the policy change.

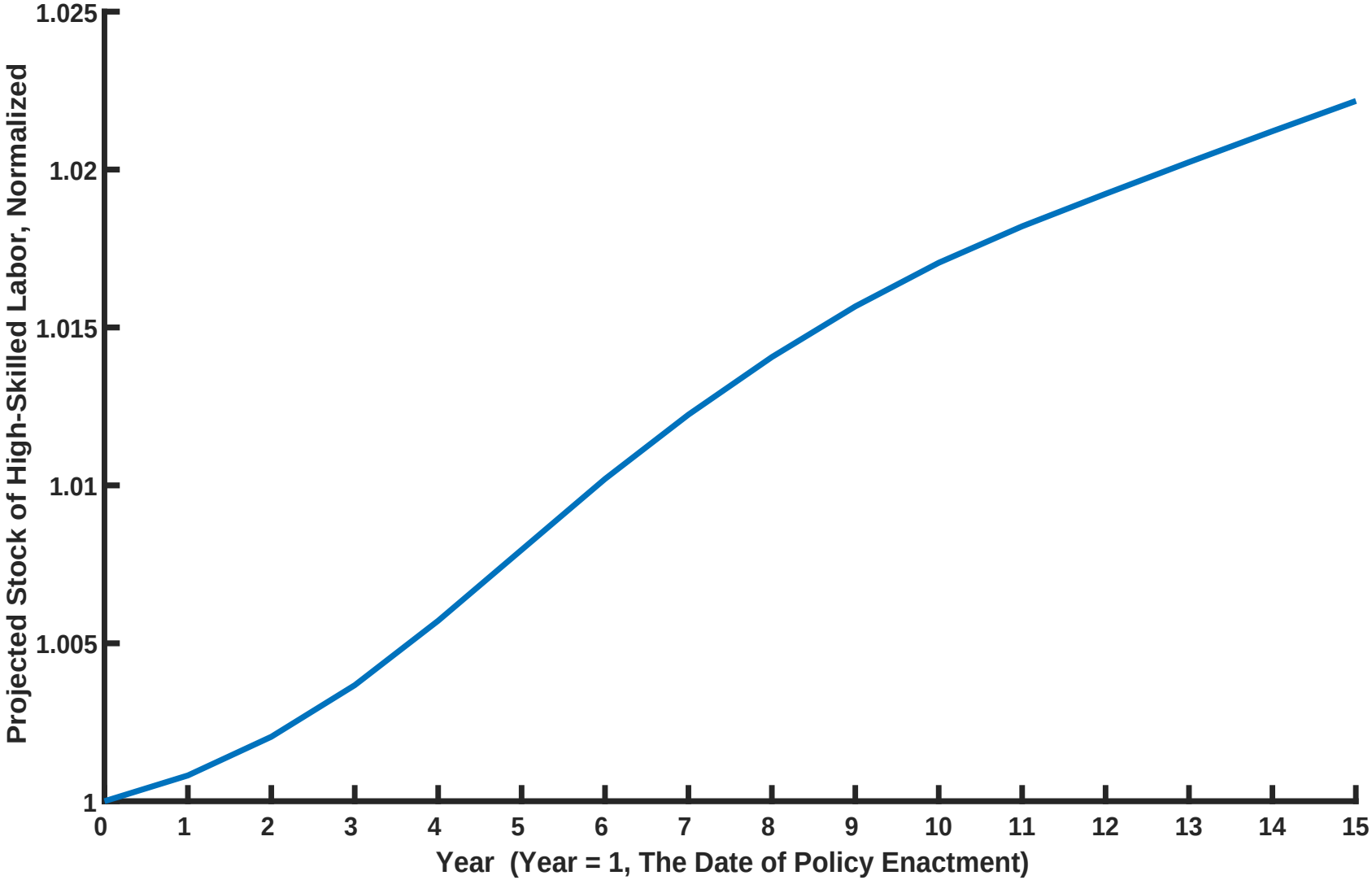
Focus on...

1. Relative wages.
2. Levels of wages, output, consumption.
3. Welfare.

Change in the Stock of H-1B Visas from I-Square Policy



Change in the Stock of High-Skilled Labor from I-Square Act



The "Lens" to Examine Relative Wage Changes

I'm going to plot the following statistic from the model:

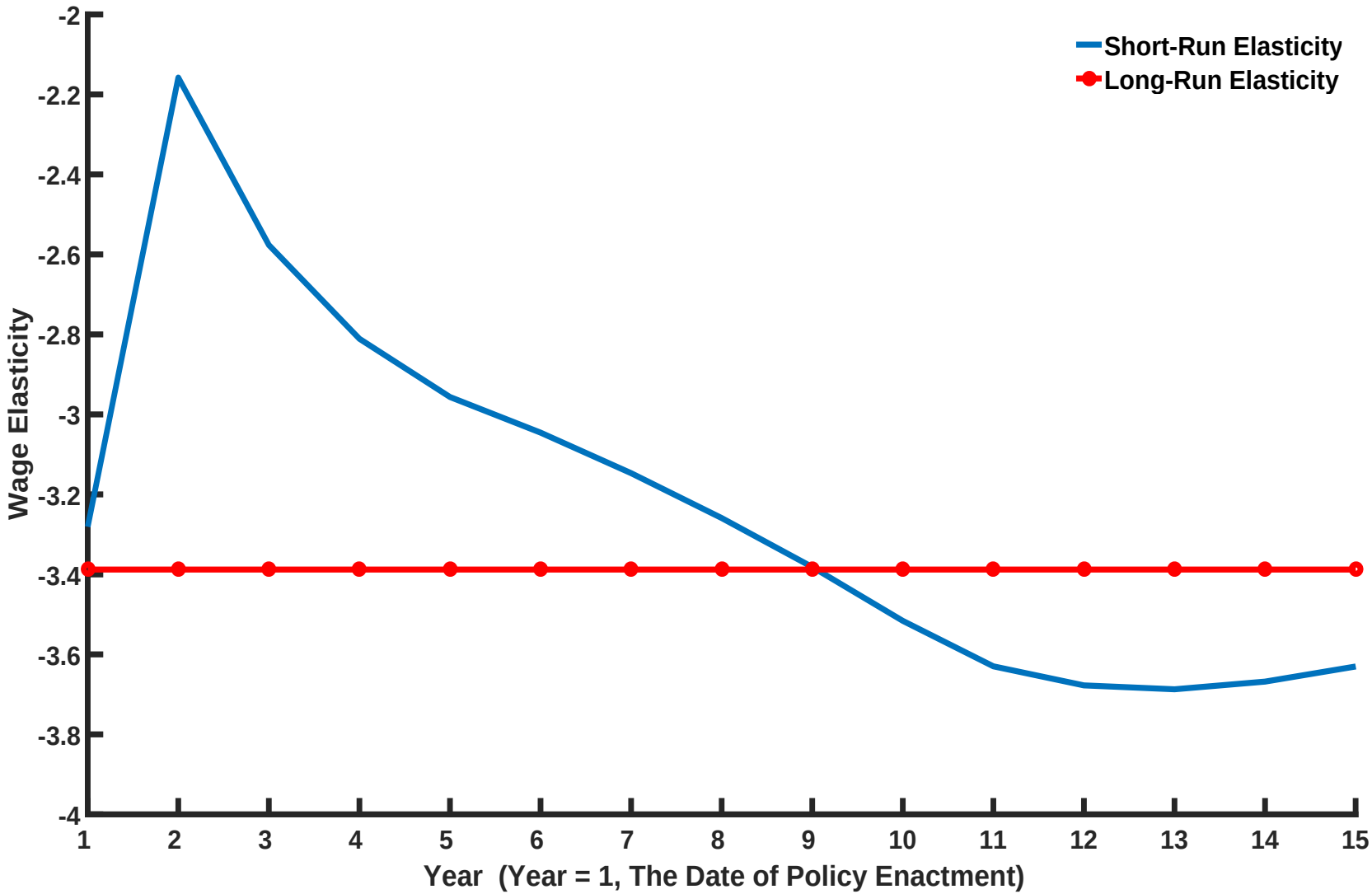
$$\hat{\theta}_t = \frac{d\log(L_{st}) - d\log(L_{ut})}{d\log(w_{st}) - d\log(w_{ut})}.$$

In the standard model, this should be constant and take the value -3.

- Hence the deviation from -3 is informative.
- If $\hat{\theta}_t > -3$, then the skill-premium is contracting by **more** than the standard model would predict.

This is essentially how Borjas (2003), Card (2009), Ottaviano and Peri (2012), etc., evaluate the response of wages.

Wage Elasticity: $\frac{d\log(L_{st})-d\log(L_{ut})}{d\log(w_{st})-d\log(w_{ut})}$

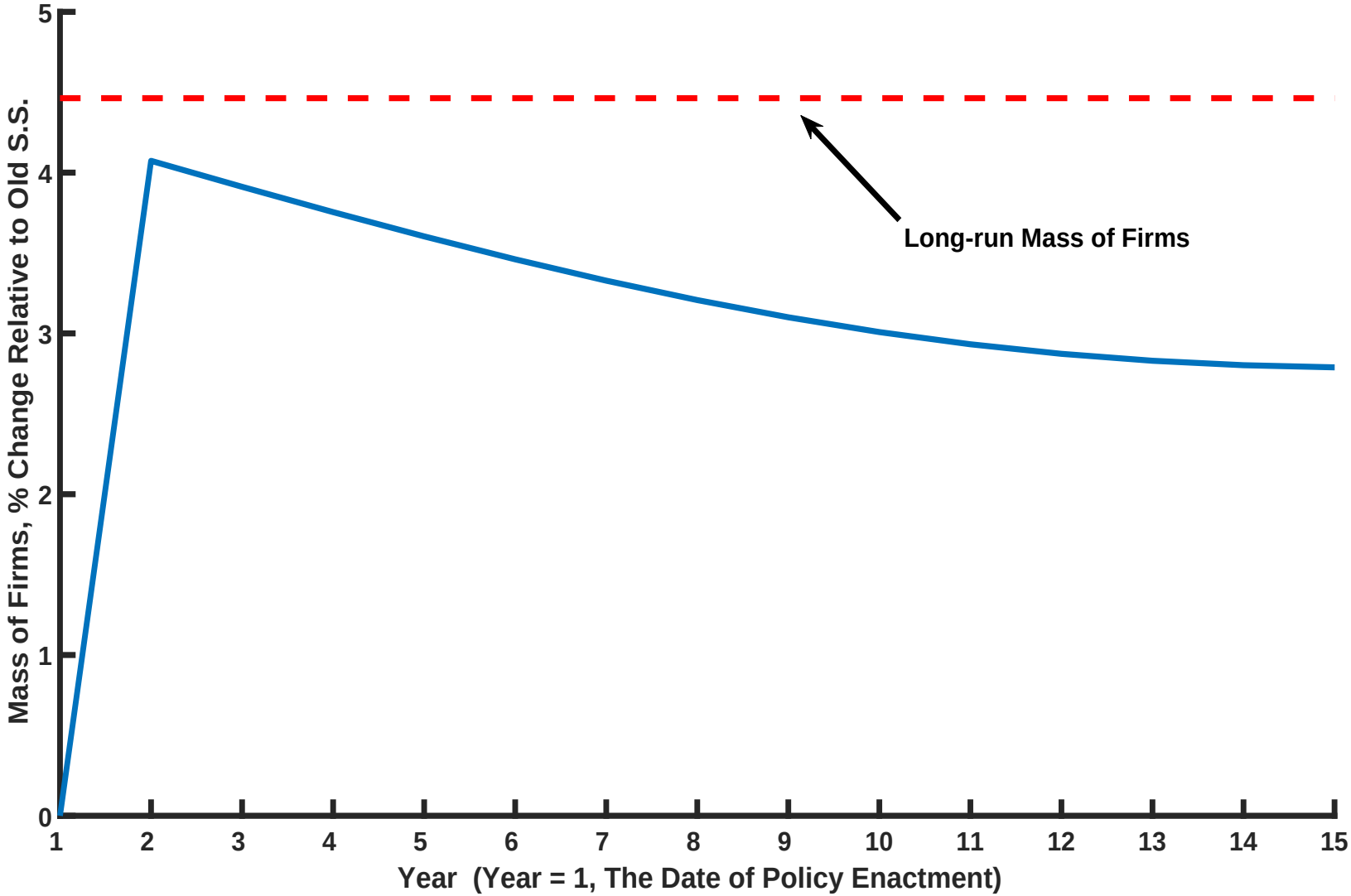


Entry Dynamics and S-P Mechanism $\Rightarrow$ Horizon-Varying Elasticities

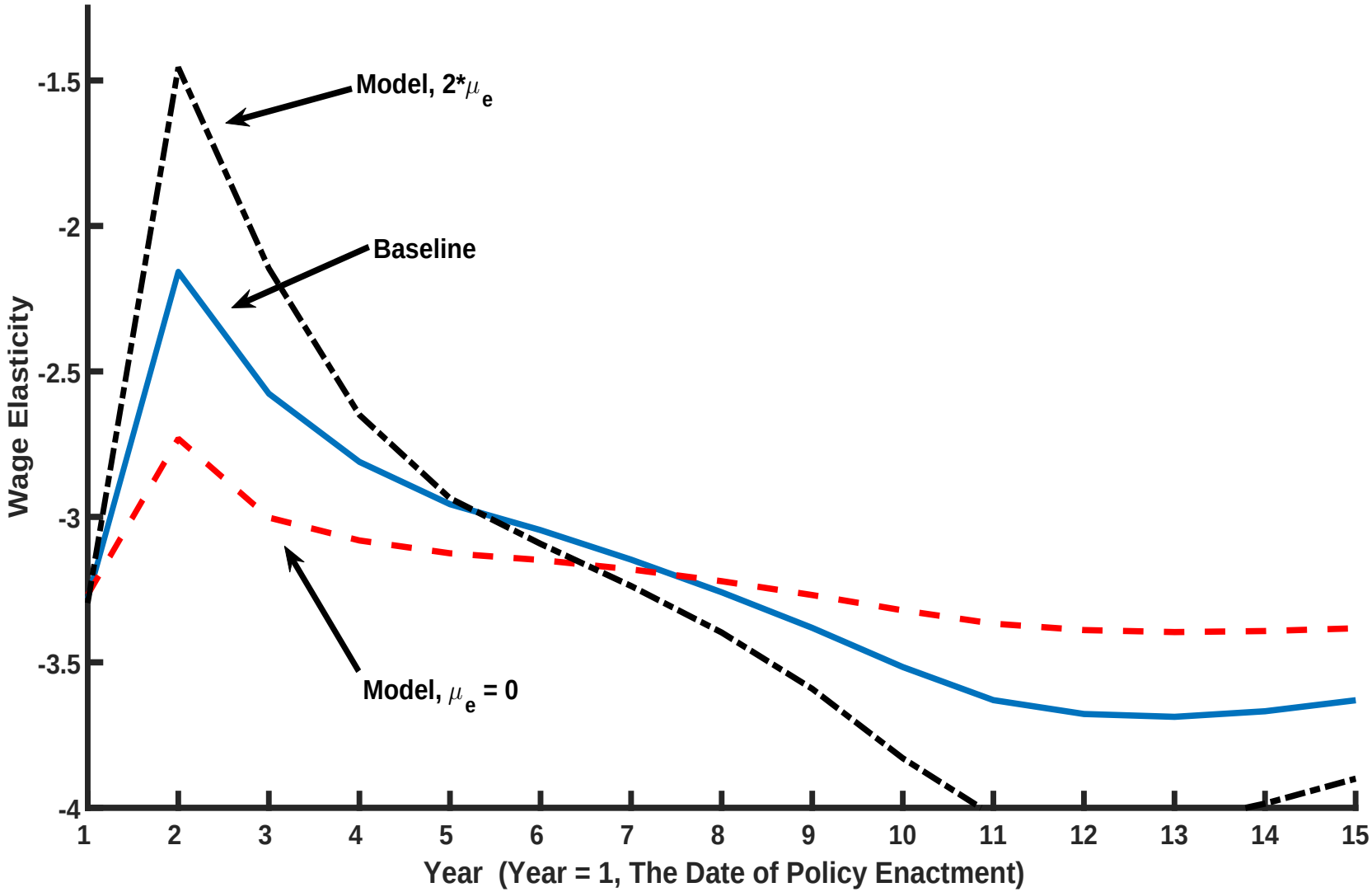
In the short-run, the skill premium contracts much more than a standard, constant-elasticity model would predict. Why?

- Immigration increases the size of the market (today and in the future), so firms enter.
- Entrants are less productive *and* are low-skill intensive.
- Thus, entry bids up the low skill wage and the the skill-premium decreases by more than predicted by a standard, static, constant-elasticity model.

Mass of Entering Firms



Wage Elasticity: Different Entry Distributions



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Supporting evidence:

- Olney (2013) for US, Dustmann and Glitz (2015) for Germany: Δ Firms/establishments correlate with Δ Immigration.
- Karahan, Pugsley, and Şahin (2016): demographic changes in US have a large effect on the startup rate of firms.

Entry Dynamics and S-P Mechanism ⇒ Horizon-Varying Elasticities

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- Thus, entry bids up the low skill wage and the the skill-premium decreases by more than predicted by a standard, static, constant-elasticity model.

Supporting evidence:

- This is a model + data outcome. To match the high exit rate of new firms, they must be less productive than the average incumbent is.
- This fact has been well documented, see, e.g., Baily, Hulten, and Campbell (1992) or Bartelsman and Doms (2000).

Entry Dynamics and S-P Mechanism ⇒ Horizon-Varying Elasticities

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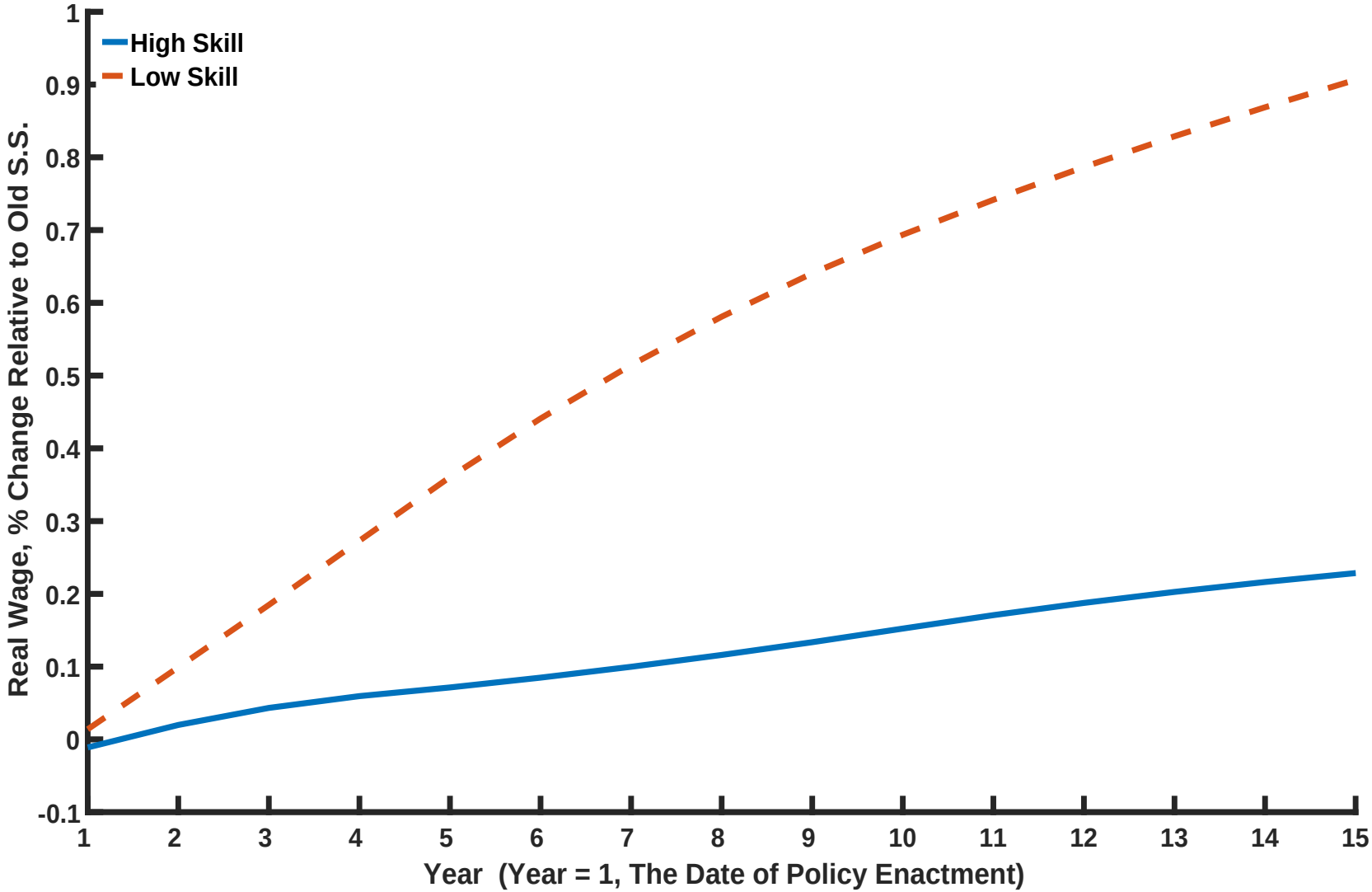
- Immigration increases the size of the market (today and in the future), so firms enter.
- Entrants are less productive *and* are **low-skill intensive.**
- Thus, entry bids up the low skill wage and the the skill-premium decreases by more than predicted by a standard, static, constant-elasticity model.

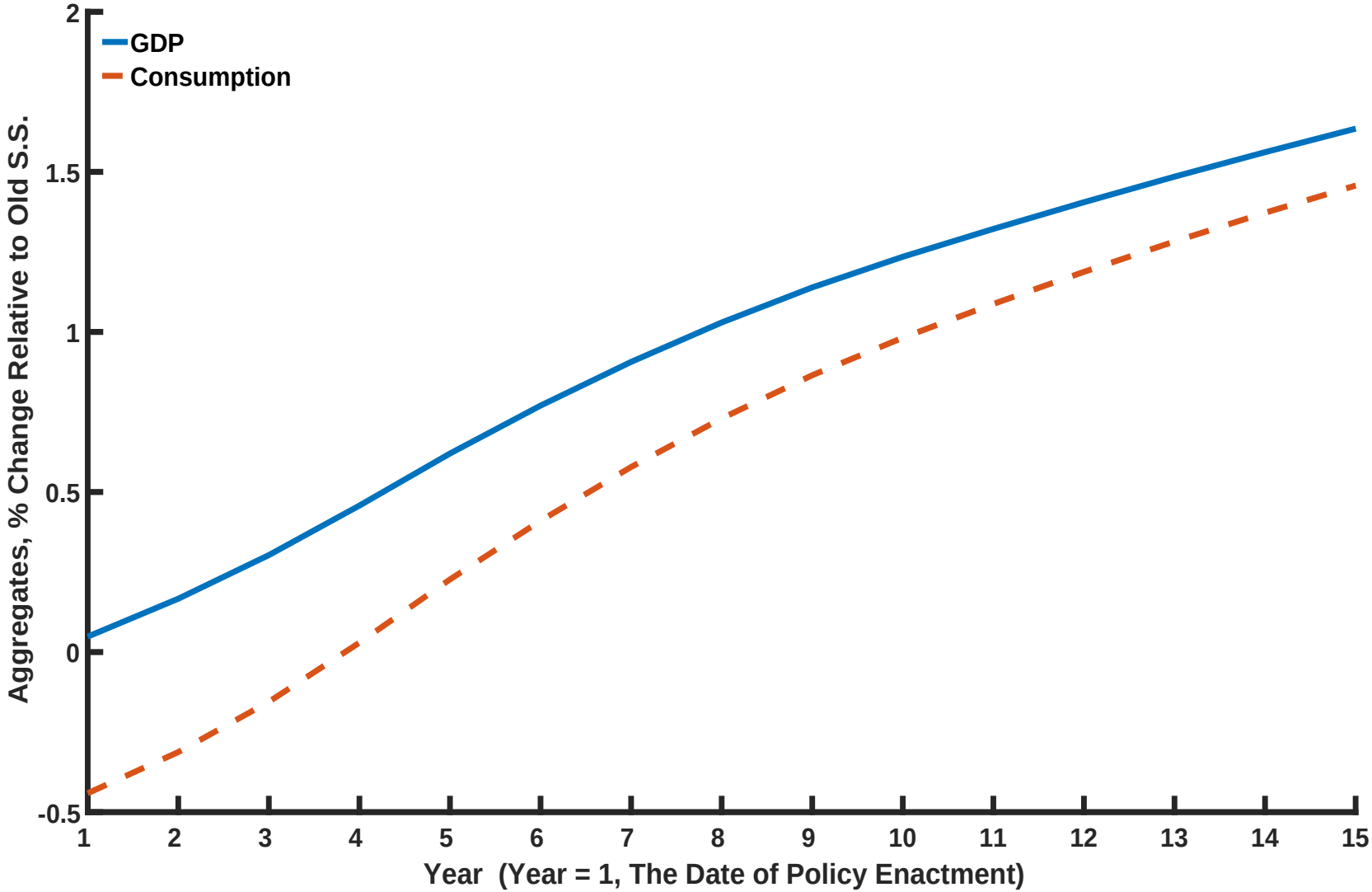
Supporting evidence:

- This is a model + data outcome. To match the size-wage premium, skill intensity must increase with productivity.
- Trade: Bernard and Jensen (1995), Schank, Schnabel, and Wagner (2007), and Burstein and Vogel (2016). IO: Fox and Smeets (2011).

Wage Levels


High Skill
Low Skill
Real Wage, % Change Relative to Old S.S.
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Year (Year = 1, The Date of Policy Enactment)

Aggregate Consumption and Output



Welfare

Key issue: How to distribute profits to consumers/workers. . .

Assumption: Consumers of a skill type receive a wage-bill weighted share of profits net of entry costs.

- This allocation rule implies that consumption of for skill type i is

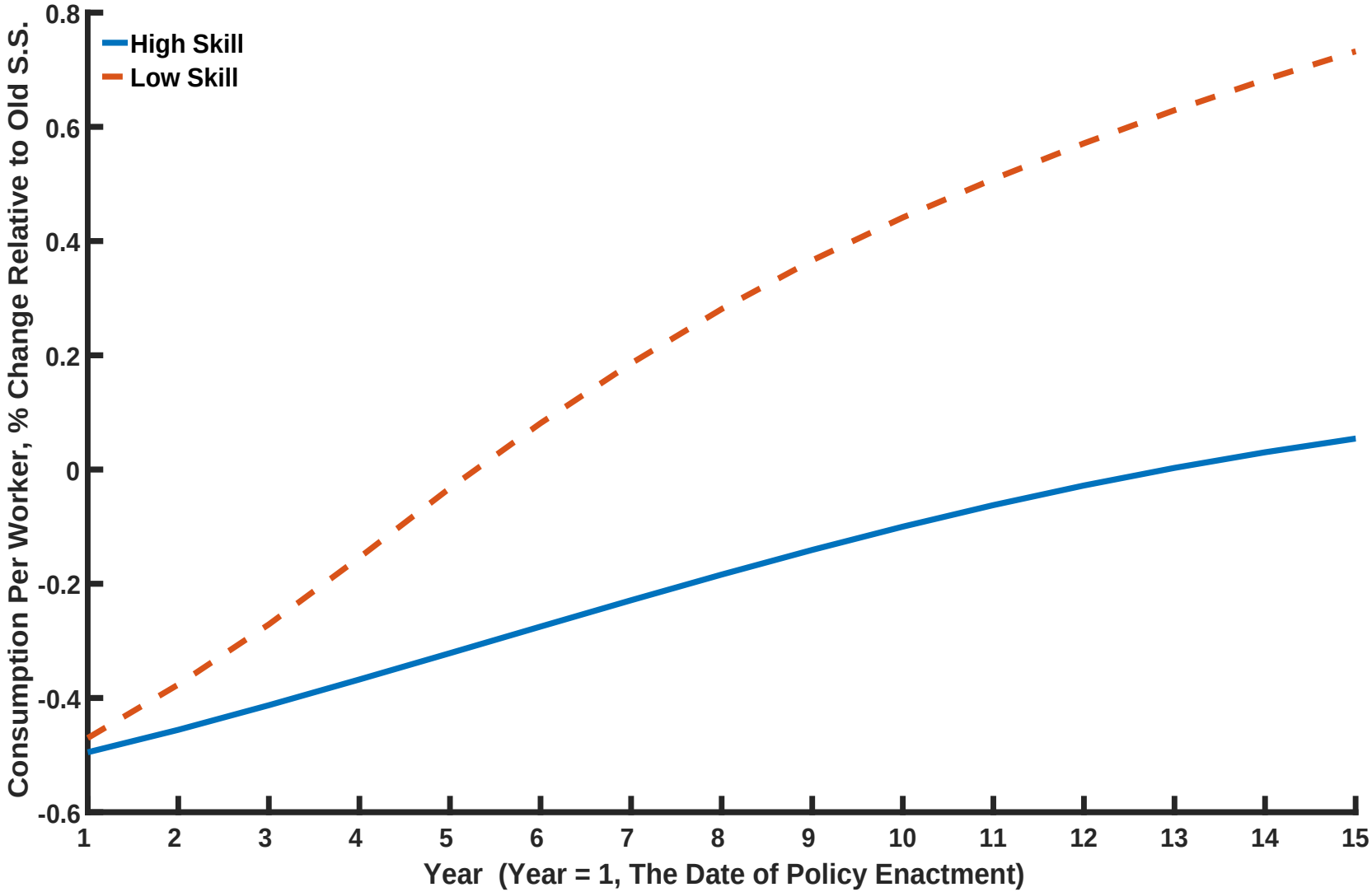
$$c_i = w_i + \Pi \left(\frac{w_i}{w_u L_u + w_s L_s} \right).$$

  where Π is aggregate profits; $\left(\frac{w_s}{w_u L_u + w_s L_s} \right)$ is the wage-bill share that a skilled worker receives.

Evaluate the consumption/ welfare gain of the worker in each skill group.

- Welfare gain is the percent increase the present discounted value of consumption relative to the old equilibrium.

Consumption by Worker Type



Welfare

Consumption Per Worker and Welfare

	Consumption	
	Year One	Across Steady States
High Skill	-0.49	0.65
Low Skill	-0.47	2.46
	Welfare	
	Welfare Gain	No Transition
High Skill	0.22	0.65
Low Skill	1.29	2.46

Note: All numbers in percent. "Welfare Gain" is percent increase the present discounted value of consumption relative to the old equilibrium. "No Transition" is without the transition path.

Takeaways...

1. Negligible, negative effects on wages in the short run.
   - Labor demand shifts. Firm entry mutes reductions in wages.

2. Short-run losses in consumption. Long-run gains for all.
   - Consumption falls on impact as new firms "invest" to take advantage of the larger pool of labor today and in the future.
   - Expansion in variety or "product innovation" from a larger labor force, leads to long-run gains for all.

3. Transition dynamics are important for evaluating welfare.

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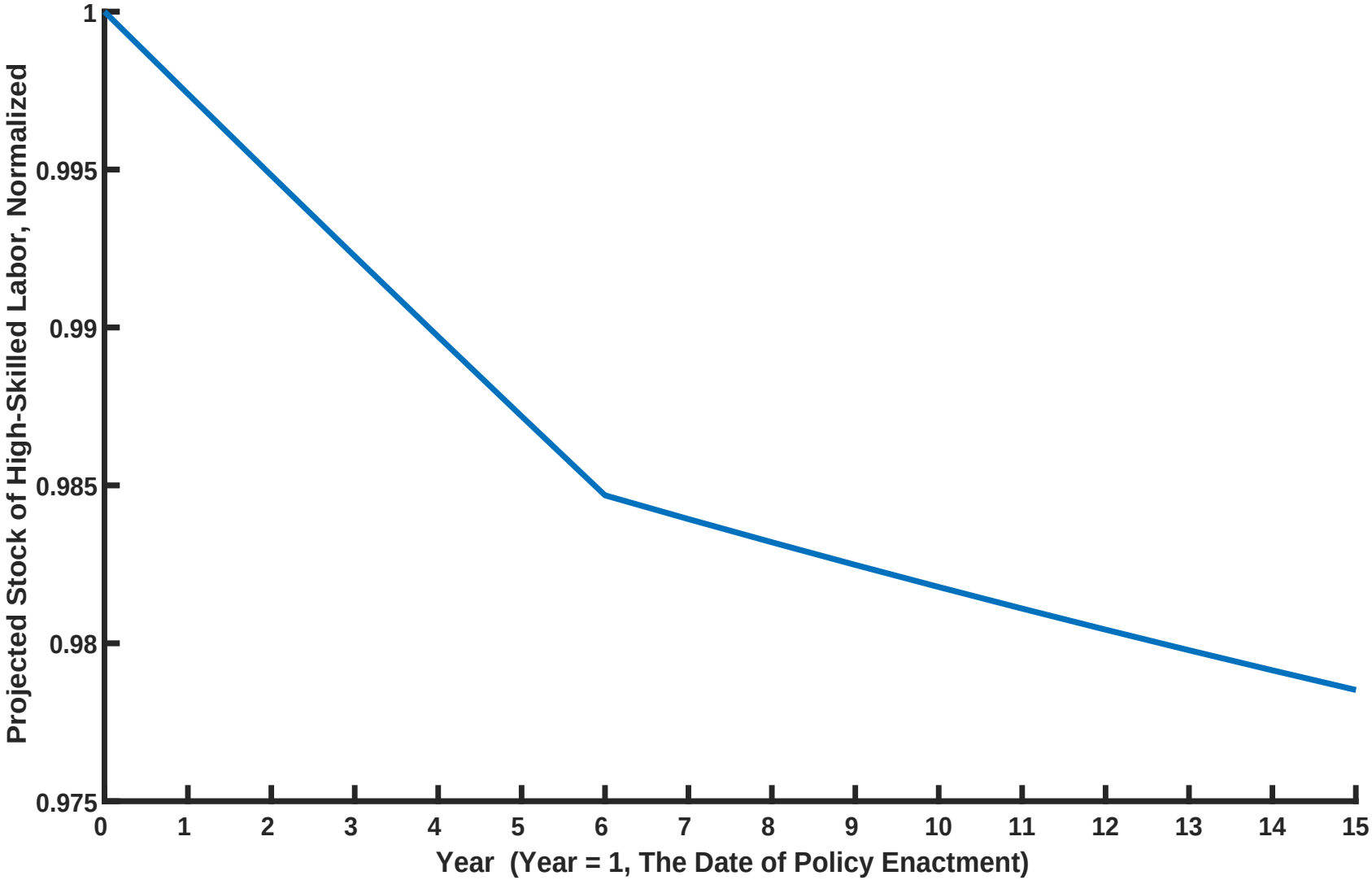
Policy Experiment: Eliminate High-Skilled Immigration

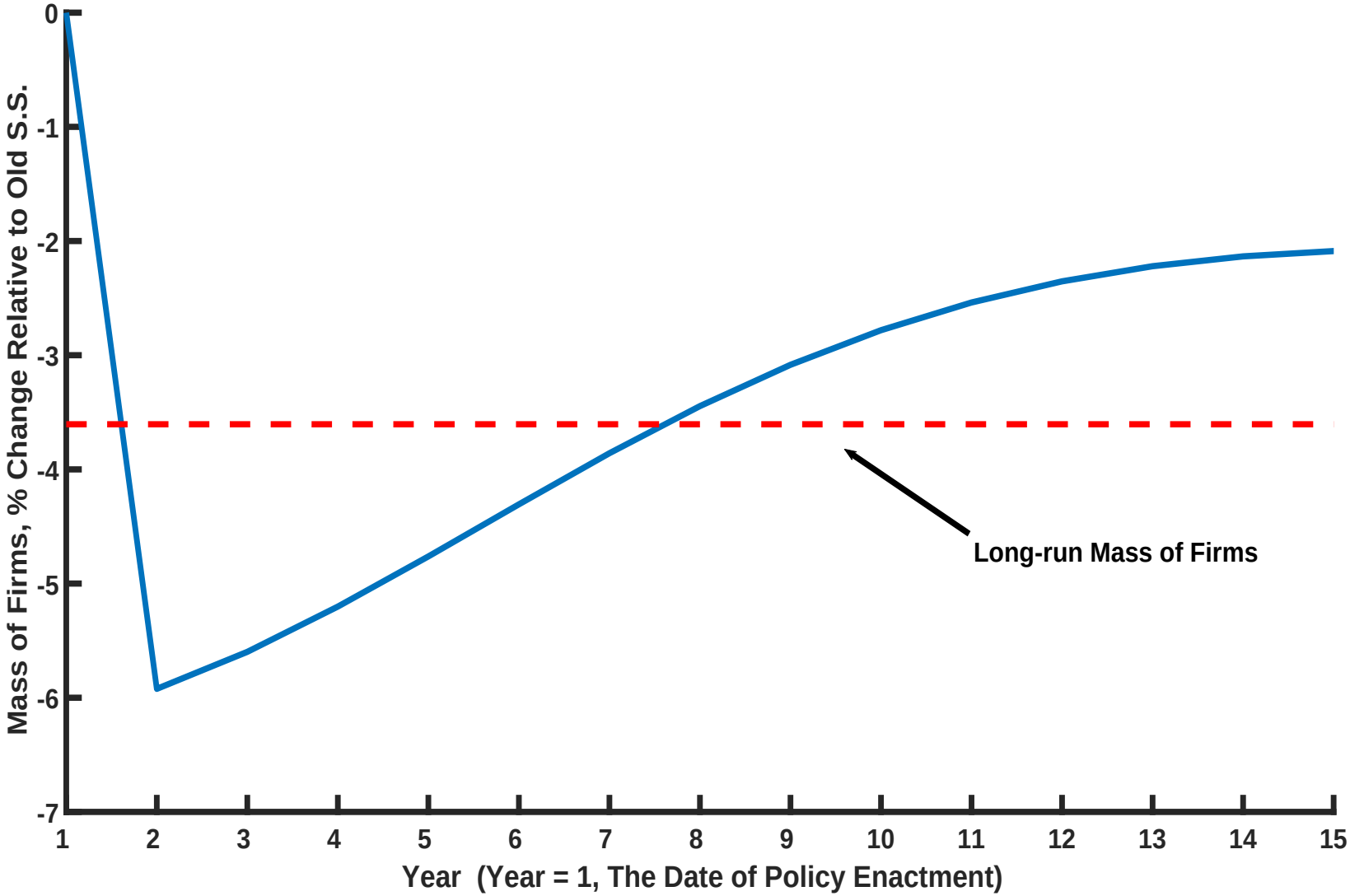
Implement the nationalistic policy. . .

- No new H-1B visa holders are allowed in. Thus, no longer a flow of 85,000 high-skilled workers into the economy.
- Existing H-1B visas holders can remain for the maximum duration of six years; Existing H-1B visa holders cannot change their visa status
- Treat the change in policy as unanticipated. Compute the transition of the economy given the policy change.

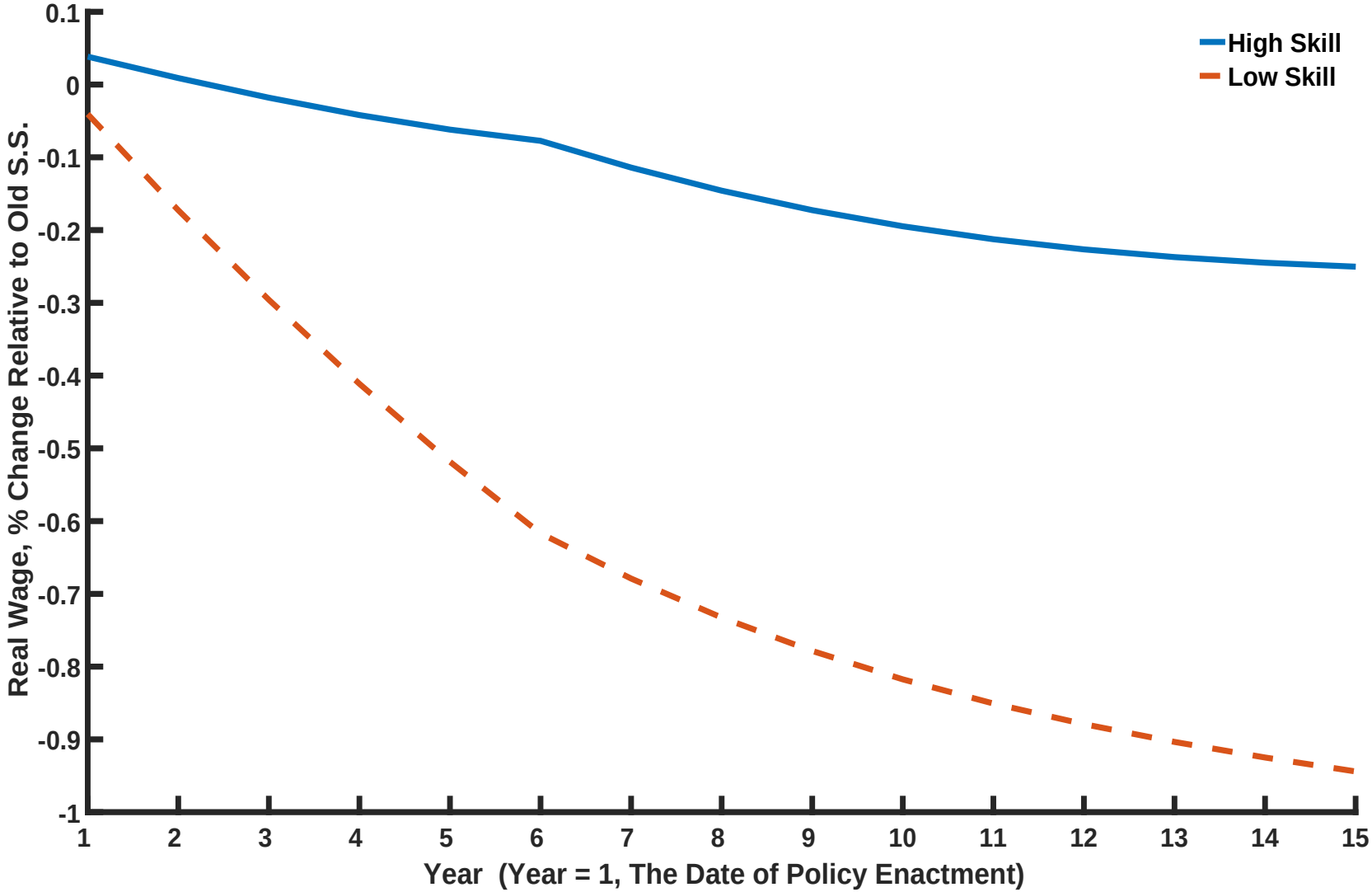
Nationalistic Policy: Change in the Stock of High-Skilled Labor



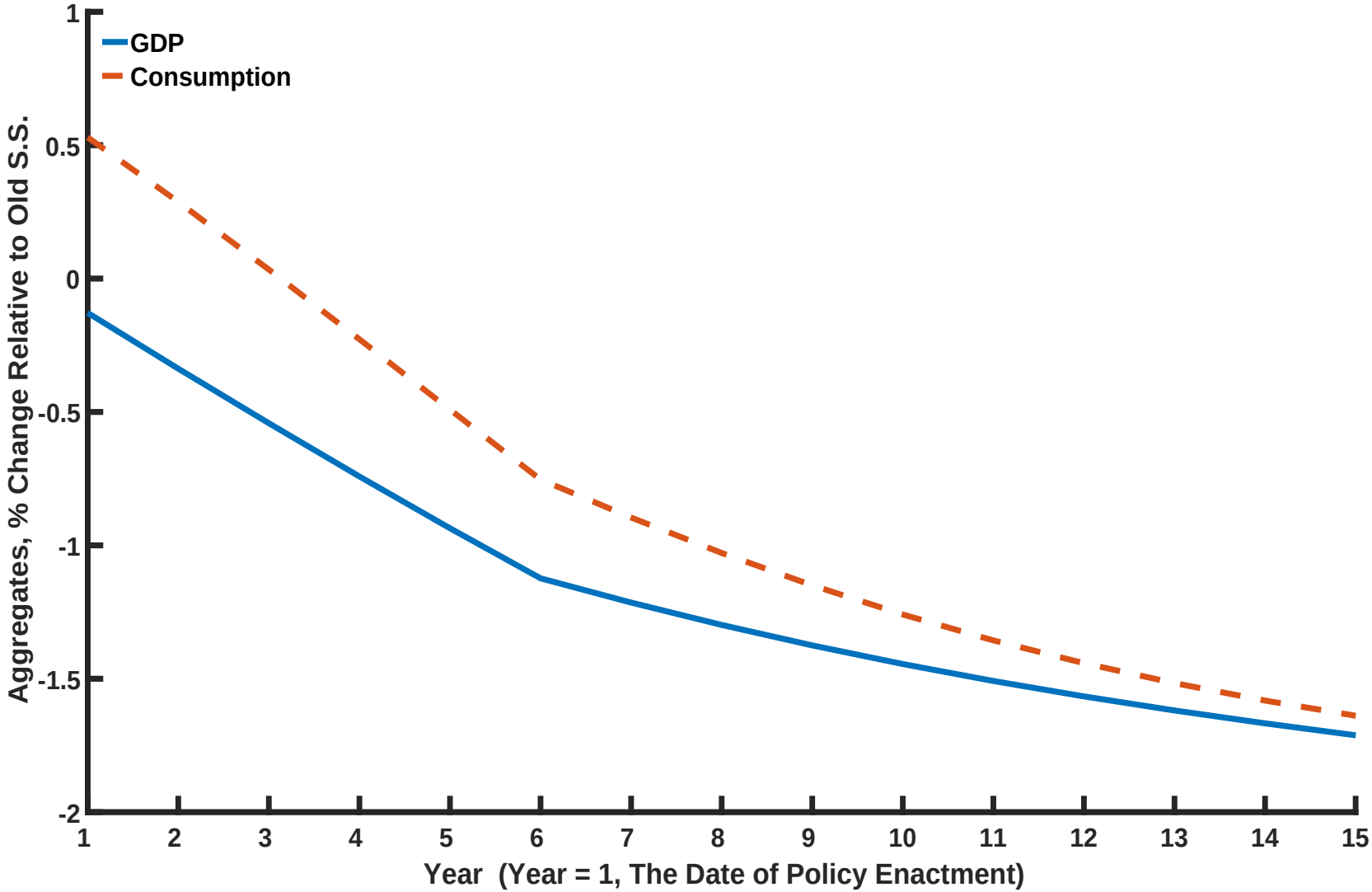
Nationalistic Policy: Mass of Entering Firms



Nationalistic Policy: Wage Levels



Nationalistic Policy: Aggregate Consumption and Output



Nationalistic Policy: Welfare

Consumption Per Worker and Welfare

	Consumption	
	Year One	Across Steady States
High Skill	0.70	-0.50
Low Skill	0.62	-1.94
	Welfare	
	Welfare Gain	No Transition
High Skill	-0.19	-0.50
Low Skill	-1.13	-1.94

Note: All numbers in percent. "Welfare Gain" is percent increase the present discounted value of consumption relative to the old equilibrium. "No Transition" is without the transition path.

Nationalistic Policy Takeaways...

1. Negative effects on the wages of low-skilled workers in the short run; negligible increase in the wages of high-skilled.

- Firm entry declines, demand for unskilled labor falls.

2. Short-gains in consumption. Long-run losses.

- Consumption increases on impact as less investment is necessary.
- Scale-effect leads to long-run losses for all.

Open Questions...

Firm Dynamics and the Distributional Impacts of Immigration.

- Firm dynamics + immigration $\Rightarrow$ short-run wage responses $\neq$ long-run.
- Key issue: the skill-bias of entrants relative to incumbent firms?

The Aggregate Impacts of Immigration.

- Wage dynamics came from quick firm entry. Key issue: What is the elasticity of firm entry to labor supply?
- Long-run gains come from a scale effect. Hard to sort out in data, but a critical piece of the gains.

Who Bears the Burden of Adjustment?

- Its not about workers, but the owners of the firm. In other words, Mark Zuckerberg and Bill Gates want the policy change, they bite the bullet.

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