The Macroeconomic Implications of the Gen-AI economy[a]

AI-nomics: Understanding the Macroeconomics of the Artificial Intelligence Era

Pablo A Guerrón Quintana[1] and Tomoaki Mikami[1] and Jaromir Nosal[1]

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[1]Boston College

[a]Disclosure: This presentation was done with Claude.ai's help.

Motivation

Nvidia CEO Jensen Huang Said, "This Is the Beginning of a New World" Thanks to Artificial Intelligence (AI). 1 Stock to Buy If He's Right

By Danny Vena – Apr 16, 2024 at 3:09PM

KEY POINTS

- The chipmaker-in-chief thinks AI will change the world as we know it.
- Generative AI can streamline time-consuming tasks.
- Microsoft has been working behind the scenes to develop digital helpers.
- Motley Fool Issues Rare "All In" Buy Alert

Generative AI could raise global GDP by 7%

Published on 05 APR 2023

Topic: ARTIFICIAL INTELLIGENCE

Goldman Sachs

The four companies say they launched the Frontier Model Forum to ensure 'th
models' © FT montage

FINANCIAL TIMES

myFT

Advertising + Add to myFT

AI advertising start-up valued at $4bn after fundraising

The Brandtech Group will use funds to disrupt industry with machine-generated content and artificial intelligence

CIO JOURNAL

At Moderna, OpenAI's GPTs Are Changing Almost Everything

'People literally talk about how AI is going to cure diseases someday, and I think this is a very meaningful first step,' said OpenAI CEO Sam

+14%

PwC research shows global GDP could be up to 14% higher in 2030 as a result of AI – the equivalent of an additional $15.7 trillion – making it the biggest commercial opportunity in today's

What we do

- Artificial Intelligence (AI) is a potentially transformative innovation of our time, permeating various facets of our daily lives.
- It is crucial to understand the implications of AI on the macroeconomy.
- Questions surrounding AI
  - What is the contribution of the AI revolution to the overall economy?

    Some industry estimates put the contribution at between 7% and 14% over next decade.
  - How does it affect capital and labor across sectors?
  - How does it compare to previous Industrial Revolutions?
- We need a **quantitative macro model** to address these and other questions.

How we do

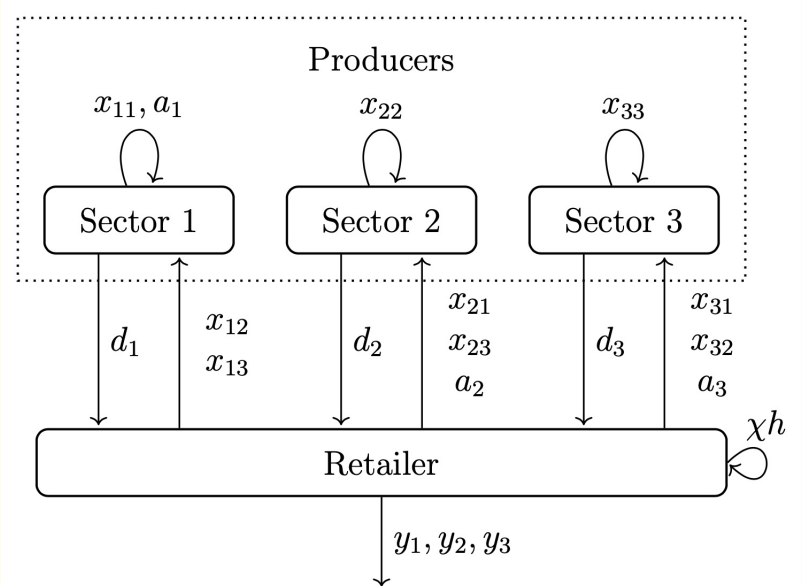
- This paper proposes a quantitative multi-sector model to capture the special role of Gen–AI.
  - AI sector improves customer management and retention in all sectors.
  - It helps to overcome frictions of customer base buildup – marketing/advertising.
- The Gen–AI component of the service sector is modeled in a customer capital search framework, which makes costumer base valuable.
- Model is calibrated to match size of AI service sector and Input-Output structure of U.S.

What we find

- Goldman Sachs estimates a potential increase by 7 p.p. in GDP next decade.
- Productivity in AI sector must increase by around 12% to deliver a 7 p.p. increase in GDP in a 10-year horizon.
- Large permanent reallocation of labor from AI services (-3%) to other sectors with no impact on aggregate labor (0.02%).
- Permanent increase in aggregate capital (7%) driven by growth in all sectors.
- Significant spillovers of productivity gain from AI sector to rest of economy.
- Search frictions drives about half of the response, I-O explains the rest.

Model

Model Overview



Model Overview

- Three sectors based on AI exposure (Goldman Sachs report):
  - Type I: services highly susceptible to AI (e.g., data processing, internet publishing, management) tables
  - Type II: other services with potential AI impact (e.g., real estate, education)
  - Type III: the rest (e.g., manufacturing, construction)
- Constant returns to scale production function for each sector.
- To sell goods, producers must match retailers

  Higher marketing capital increases likelihood of meeting a retailer
- Households consume, invest, supply labor, and purchase sectoral goods
- In quantitative section, we allow Input-Output structure.

Calibration

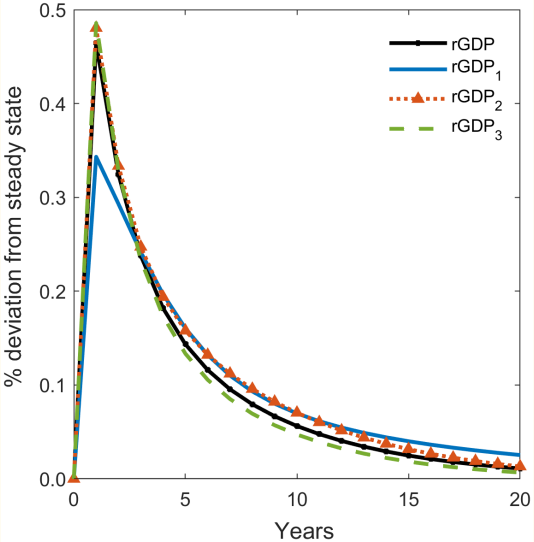
Calibration

- A period in our calibration of the model is a year.
- We use industry information at the 3-digit level and group industries in 3 sectors. ⏩ tables
- Weights in demand aggregator come from NIPA and PCE Bridge tables.
- Factor shares are computed using the "use tables" of the IO accounts from BEA.
- We use BEA-BLS Integrated Industry-level Production Accounts to compute Solow residuals in each sector.
- Sectoral PPI is constructed using BEA's supply tables. ⏩ calib

Results

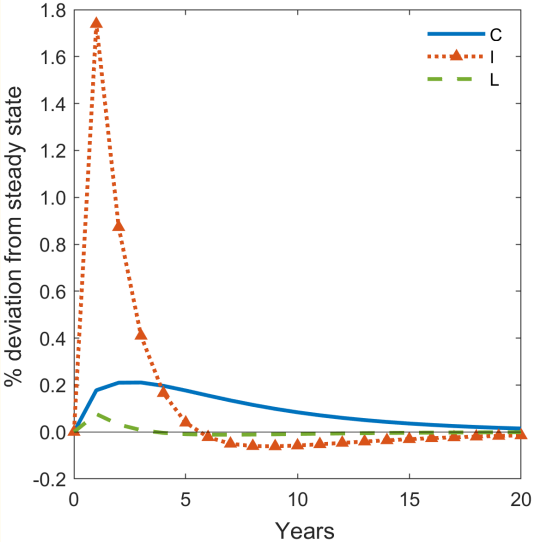
A transitory increase in productivity in sector I – AI shock

A transitory AI shock – z_1

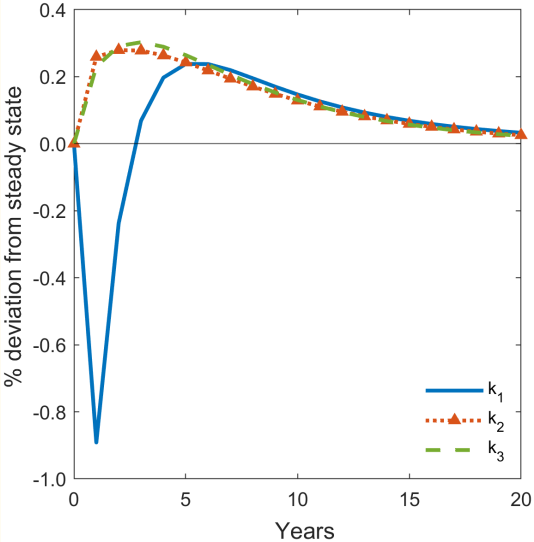


(I) GDP – baseline

A transitory AI shock – z_1

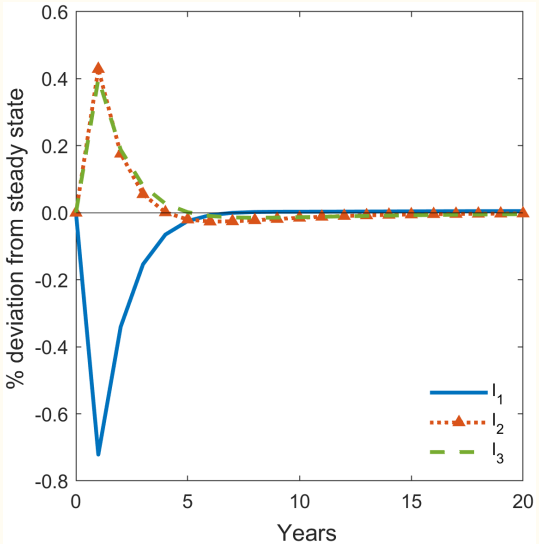


(a) Cons, Invt, and Labor

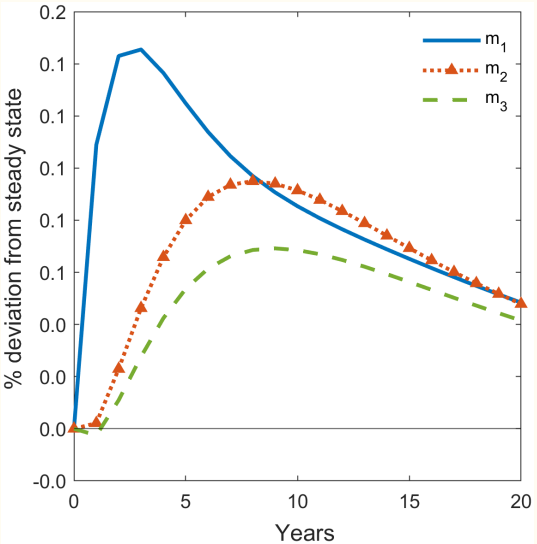


(b) Sector Capital

A transitory AI shock – z_1



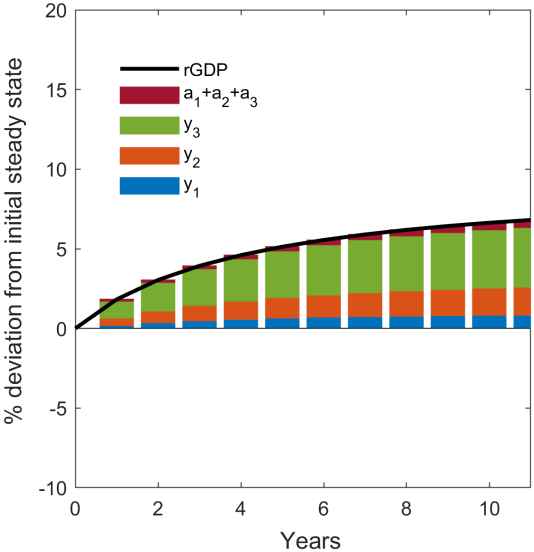
(c) Sectoral Labor



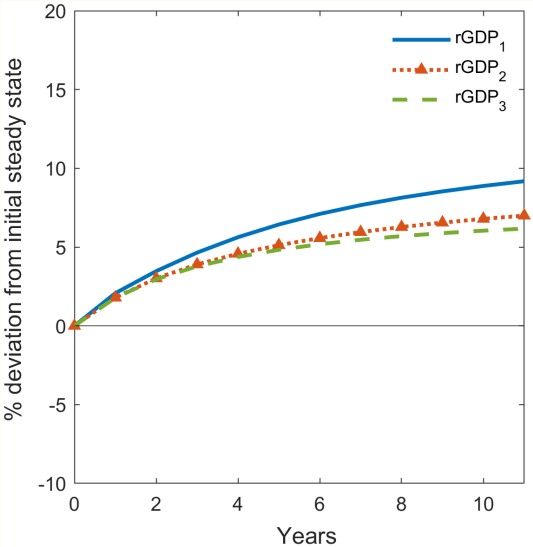
(d) Sectoral Marketing

A Goldman Sachs' shock

A Goldman Sachs' scenario – 7 p.p. GDP increase in a decade

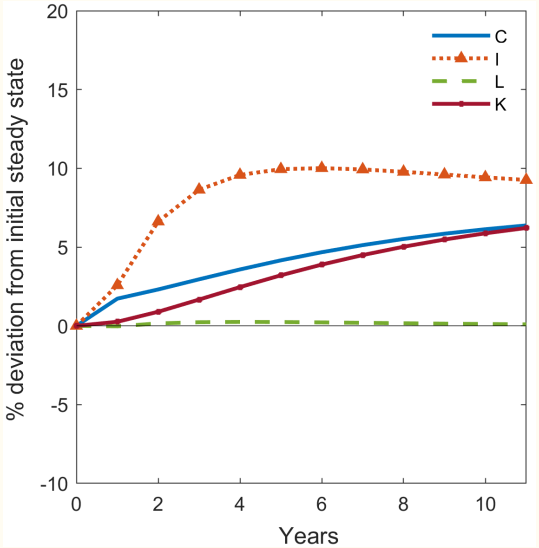


(a) Aggregate GDP

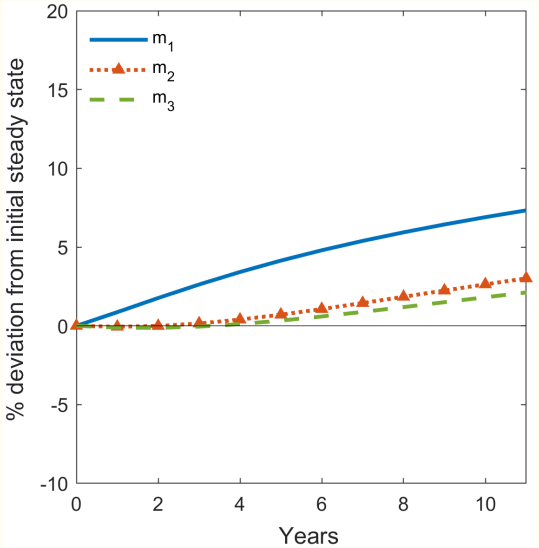


(b) Sectoral GDP

A Goldman Sachs' scenario – 7 p.p. GDP increase in a decade

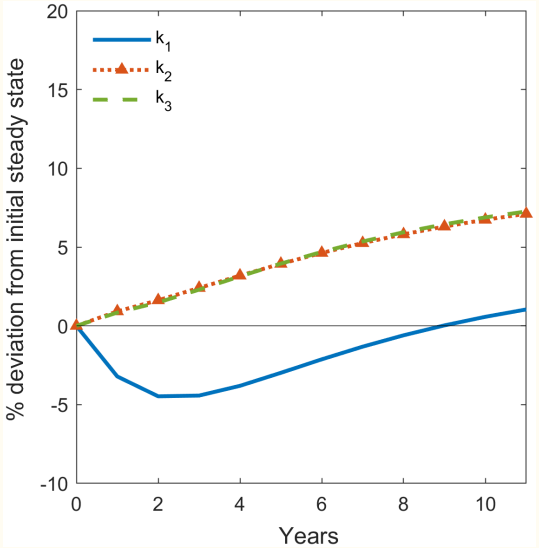


(c) Other Aggregates

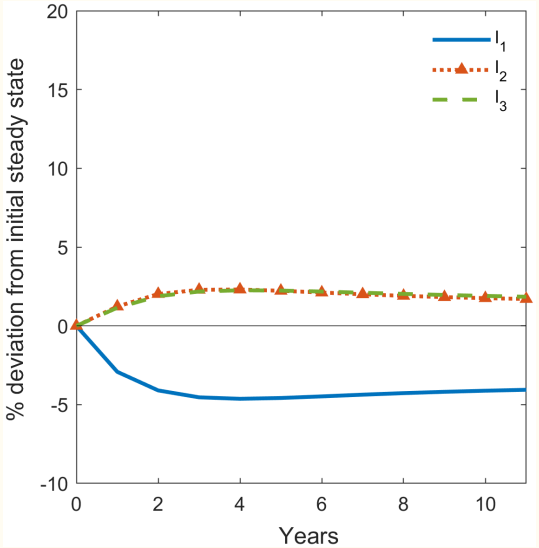


(d) Sectoral Marketing Capital

A Goldman Sachs' scenario – 7 p.p. GDP increase in a decade



(c) Sectoral Capital

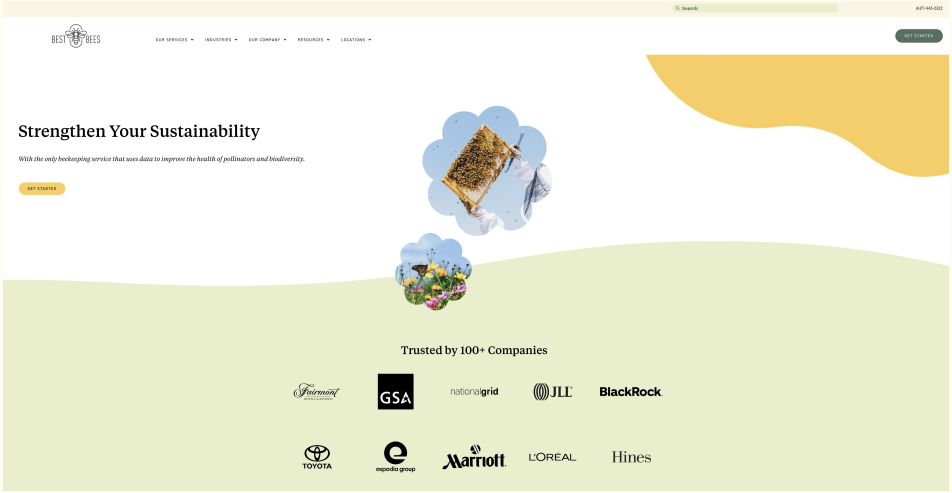


(d) Sectoral Labor

Conclusion

- Developed a multi-sector model to study the impact of AI
- Key features:
  - Three sectors with different exposure to AI
  - Marketing capital facilitates matching between producers and retailers
  - Households consume composite good aggregated from sectoral goods
- Model provides framework to analyze AI's differential impact across sectors
- Can be calibrated and simulated to generate quantitative predictions

Searching for customers



Appendix

More Introduction Slides

What we find

- A transitory improvement in productivity in the service sector leads to:
  - Cheaper to use AI good for marketing. Firms wants to attract more clients and sell more.
  - Shift away from employment and capital in AI sector; not your typical productivity shock.
  - Firms II and III produce more by increasing capital and labor
  - More retail entrants matching mostly Type I producer.
  - Strong spillovers resulting in similar p.p. gains across all sector and aggregate economy.
  - Even though AI sector is only 10% of overall economy.
  - Modest impact on aggregate employment

Table 7: Type I Classification

NAICS 3 digit	NAICS code (IO table)	Industry Description	Type
512	512	Motion picture and sound recording industries	1
515,517	513	Broadcasting and telecommunications	1
518,519	514	Data processing, internet publishing, and other information services	1
5412-5414,5416-5419	5412OP	Miscellaneous professional, scientific, and technical services	1
55	55	Management of companies and enterprises	1
561	561	Administrative and support services	1

backmodel backcalib

Table 8: Type II Classification

NAICS 3 digit	NAICS code (IO table)	Industry Description	Type
44,45	42	Wholesale trade	2
481	481	Air transportation	2
521,522	521CI	Federal reserve banks, credit intermediation, and related activities	2
523	523	Securities, commodity contracts, and other financial investments and related activities	2
524	524	Insurance carriers and related activities	2
525	525	Funds, trusts, and other financial vehicles	2
531	HS	Real estate	2
531	ORE	Real estate	2
532,533	532RL	Rental and leasing services and lessors of nonfinancial and intangible assets	2
5411	5411	Legal services	2

Model Equilibrium

Equilibrium

- Symmetric equilibrium: drop subscript i
- Market clearing for sectoral goods j:

$$z_{jt}F(k_{jt}, l_{jt}, \{x_{jmt}\}) = \begin{cases} y_{jt} + \sum_m x_{mjt} + \sum_m a_{mt} + \chi h_t & (j = 1) \quad (1) \\ y_{jt} + \sum_m x_{mjt} & (j \neq 1) \quad (2) \end{cases}$$

$$d_{jt} = \begin{cases} y_{jt} + \sum_{m \neq j} x_{mjt} + \sum_{m \neq j} a_{mt} + \chi h_t & (j = 1) \quad (3) \\ y_{jt} + \sum_{m \neq j} x_{mjt} & (j \neq 1) \quad (4) \end{cases}$$

- Labor and capital market clearing:

$$\sum_j \ell_{jt} = \ell_t$$

$$\sum_j k_{jt} = k_{t-1}$$

Calibration

Table 9: Independently calibrated parameters backcalib

Parameter	Symbol	Value
Discount factor	β	0.9
Relative Risk Aversion	σ	1.0
Inverse of Frisch labor supply elasticity	η	2.0
Elasticity of Substitution	γ	1.1
Bargaining power	θ	0.5
Physical Capital Depreciation	δ	0.1
Customer list destruction rate	δ_H	1.0

Table 10: Jointly calibrated parameters 1 backcalib

Parameter	Symbol	Value	
Parameter of labor disutility	ξ	0.6781	$\ell_{ss} = 1$
Search cost	χ	0.1150	10% gross wholesale markup

Calibration

Table 11: Jointly calibrated parameters 2 backcalib

Parameter	Symbol	Value	Target		Model	
Physical Capital Adjustment cost	ϕ	0.0000	$\sigma_i/\sigma_{\text{GDP}}$	2.808	$\sigma_i/\sigma_{\text{rGDP}}$	2.714
Marketing Capital Adjustment cost	ψ	20.9612	$\sigma_{\text{PPI}}/\sigma_{\text{PCE}}$	2.698	$\sigma_{q_1}/\sigma_{p_1}$	2.699
Persistence of productivity in Sector 1	ρ_1	0.5432	KLEMS ρ_1	0.535	rGDP_1/F_1	0.533
Persistence of productivity in Sector 2	ρ_2	0.5635	KLEMS ρ_2	0.574	rGDP_2/F_2	0.573
Persistence of productivity in Sector 3	ρ_3	0.6731	KLEMS ρ_3	0.694	rGDP_3/F_3	0.683
Standard deviation of productivity in Sector 1	$100\sigma_1$	1.5487	KLEMS $100\sigma_1$	1.252	rGDP_1/F_1	1.253
Standard deviation of productivity in Sector 2	$100\sigma_2$	0.8602	KLEMS $100\sigma_2$	0.810	rGDP_2/F_2	0.810
Standard deviation of productivity in Sector 3	$100\sigma_3$	0.7090	KLEMS $100\sigma_3$	0.670	rGDP_3/F_3	0.669