

The Macroeconomic Implications of the Gen-AI economy^a

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

Pablo A Guerrón Quintana¹ and Tomoaki Mikami¹ and Jaromir Nosal¹

October 24, 2024

¹Boston College

^aDisclosure: 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**



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



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

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.

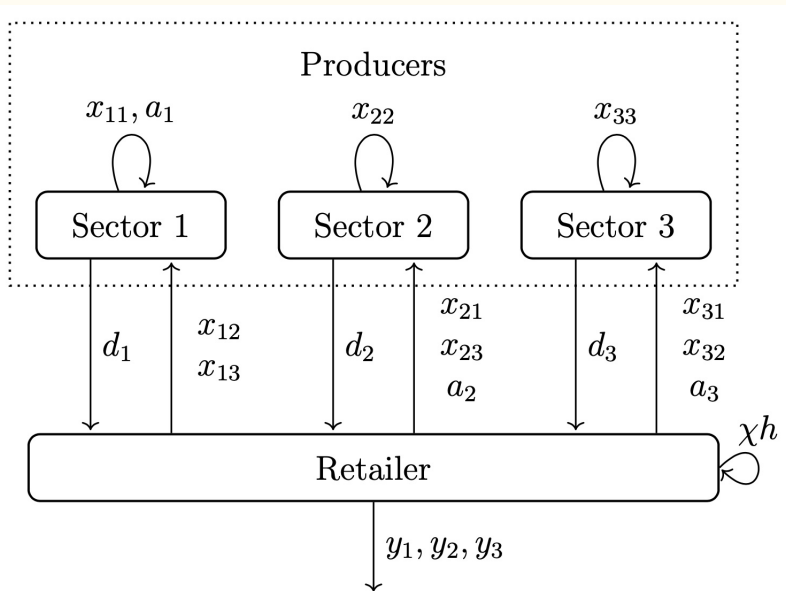
- This paper proposes a quantitative multi-sector model to capture the special role of Gen-AI.
 - AI sector improves customer management and retention in all sectors.
 - It helps to overcome frictions of customer base buildup – marketing/advertising.
- The Gen-AI component of the service sector is modeled in a customer capital search framework, which makes customer 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)
 - **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.

►► tables

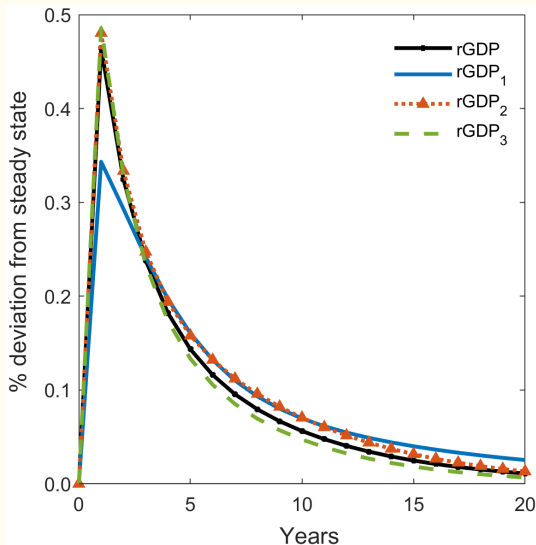
Calibration

- 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

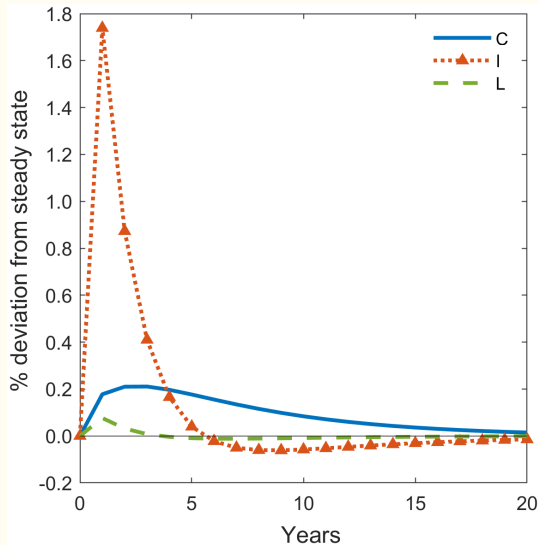
**A transitory increase in
productivity in sector I – AI
shock**

A transitory AI shock – z_1

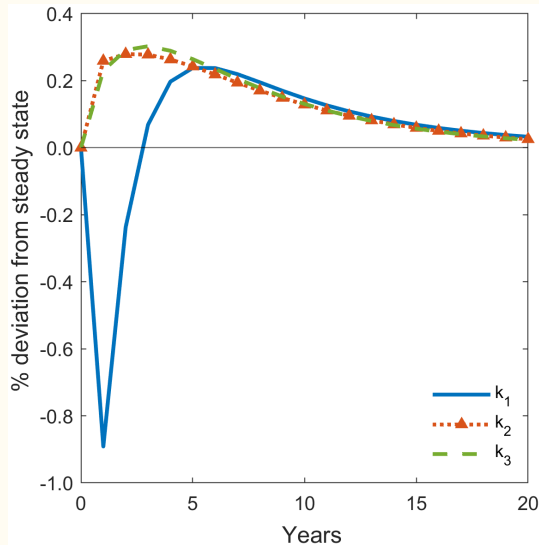


(I) GDP – baseline

A transitory AI shock – z_1

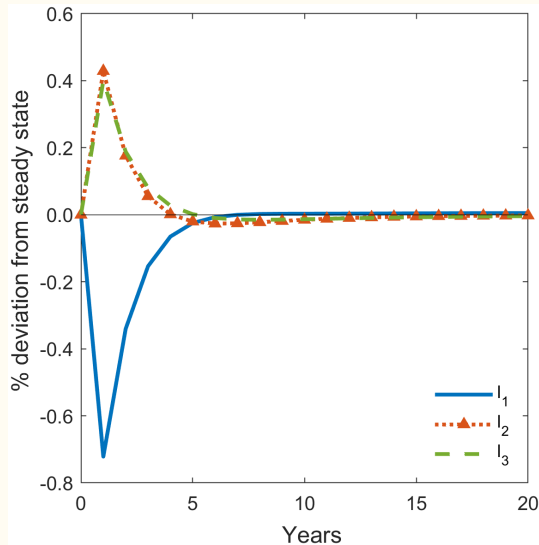


(a) Cons, Invt, and Labor

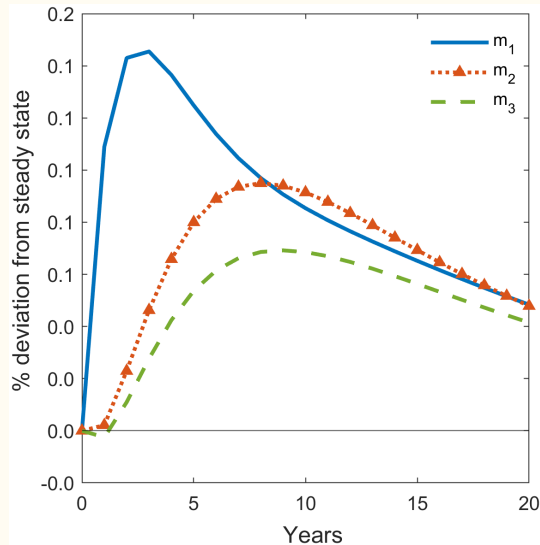


(b) Sector Capital

A transitory AI shock – z_1



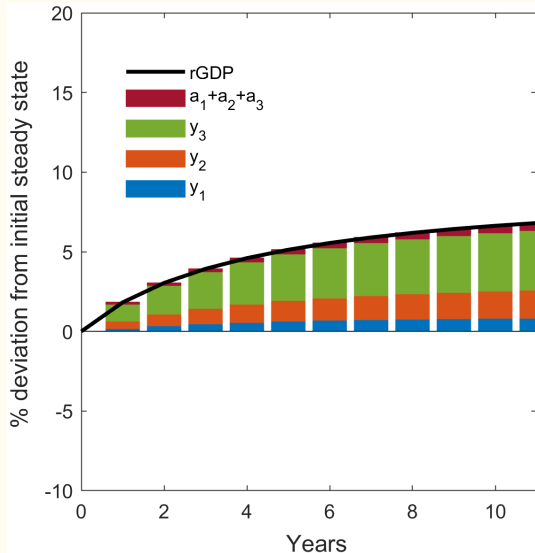
(c) Sectoral Labor



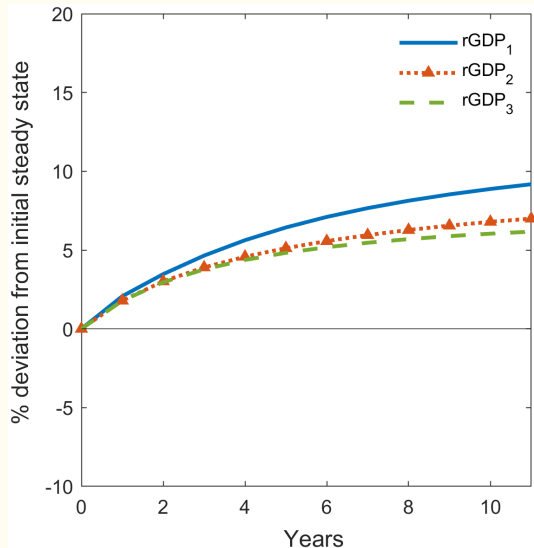
(d) Sectoral Marketing

A Goldman Sachs' shock

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

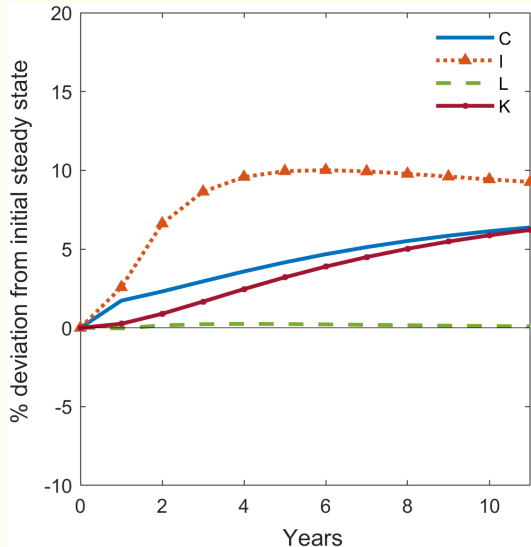


(a) Aggregate GDP

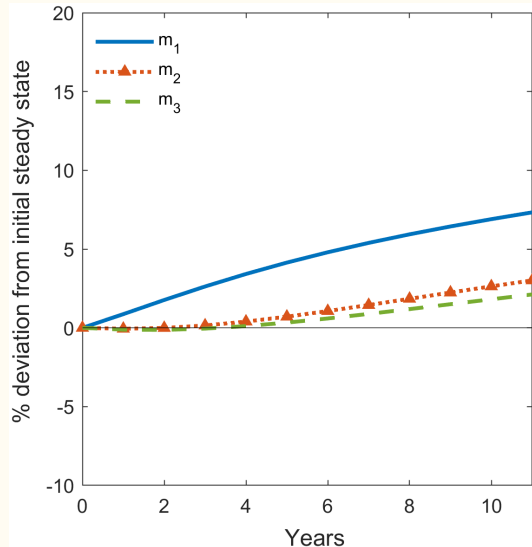


(b) Sectoral GDP

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

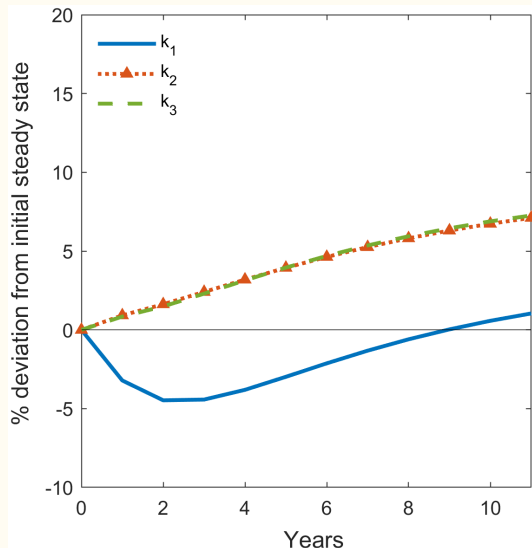


(c) Other Aggregates

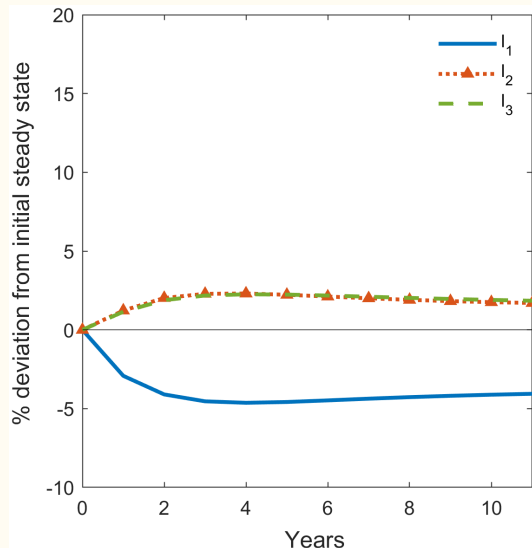


(d) Sectoral Marketing Capital

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



(c) Sectoral Capital

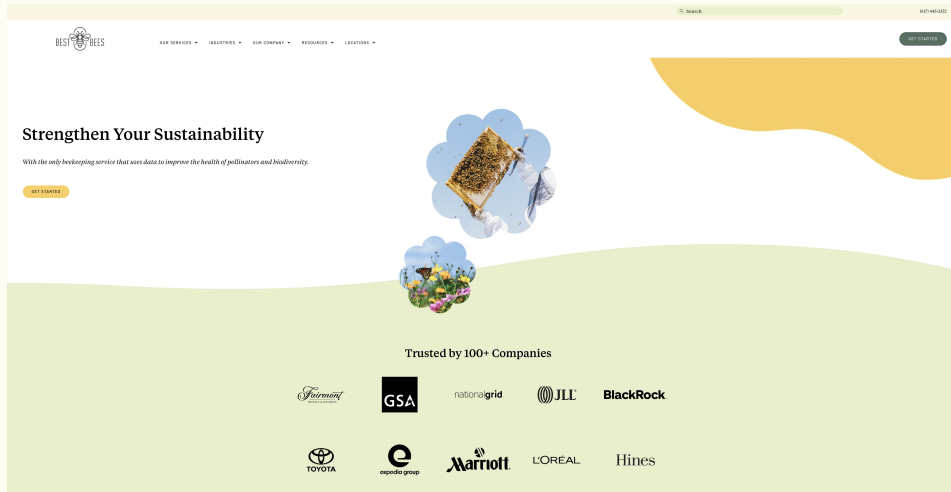


(d) Sectoral Labor

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



The screenshot shows the homepage of the Best Bees website. The header features the Best Bees logo, navigation links for Services, Industries, Company, Resources, and Locations, a search bar, and a phone number (867-445-2322). A 'GET STARTED' button is located in the top right. The main content area has a large heading 'Strengthen Your Sustainability' followed by a subtext 'With the only beekeeping service that uses data to improve the health of pollinators and biodiversity.' and another 'GET STARTED' button. Below this is an illustration of a beekeeper with a hive and a field of flowers. The section 'Trusted by 100+ Companies' displays logos for Fairmont, GSA, nationalgrid, JLL, BlackRock, Toyota, aspidia group, Marriott, L'ORÉAL, and Hines.

Strengthen Your Sustainability

With the only beekeeping service that uses data to improve the health of pollinators and biodiversity.

Trusted by 100+ Companies

Fairmont
GSA
nationalgrid
JLL
BlackRock
TOYOTA
aspidia group
Marriott
L'ORÉAL
Hines

Appendix

More Introduction Slides

- A **transitory** improvement in productivity in the service sector leads to:
 - Cheaper to use AI good for marketing. Firms want 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 :

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

$$(2)$$

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

$$(4)$$

- Labor and capital market clearing:

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

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

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

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