



DSKUS


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# Automotive Semiconductor Supply Chain Analysis

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Mitigating COVID-19  
Disruptions in the  
United States and  
South Korea

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# Semiconductors are everywhere and in everything:

- 25% Smartphones
- 20% Personal Computers
- 20% Electronics
- 15% Servers & Data Storage
- 10% Automotive

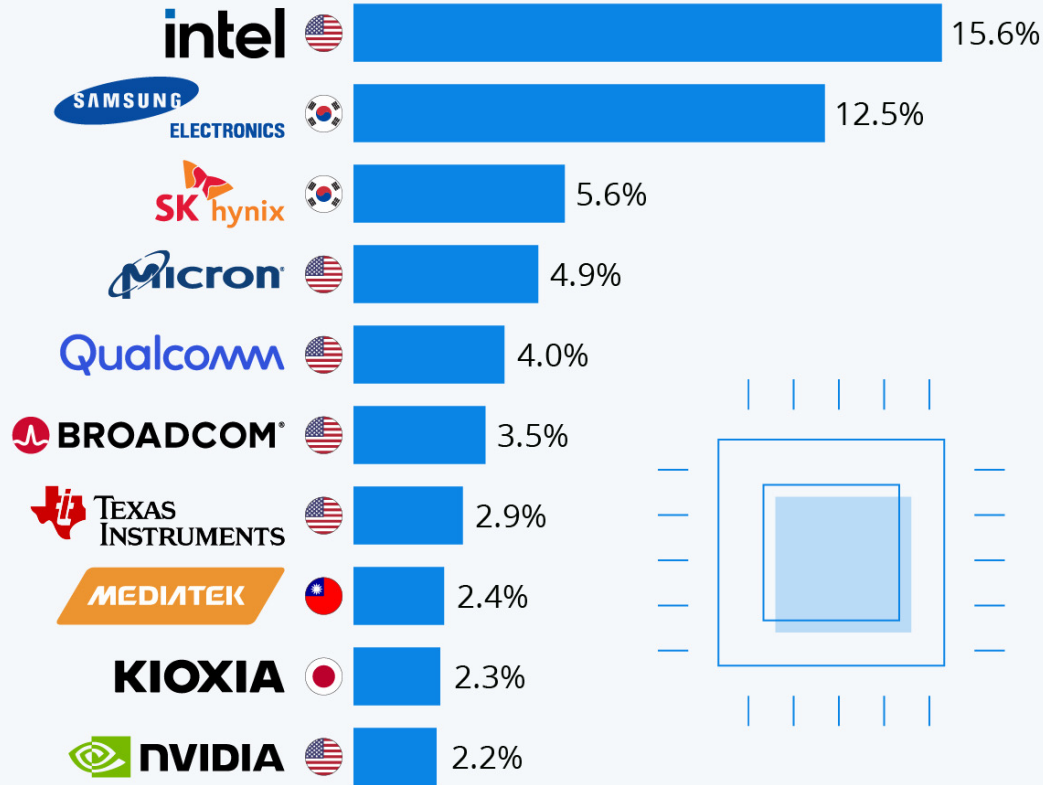
World's 4<sup>th</sup> Most Traded Product.

The average car is packed with 1,400 semiconductors or 'chips' that control everything from airbags to engine.

*\*Source: Detroit Free Press, Statista 2021*

# Intel and Samsung Lead Global Semiconductor Production

Market shares of the world's biggest semiconductor producers in 2020



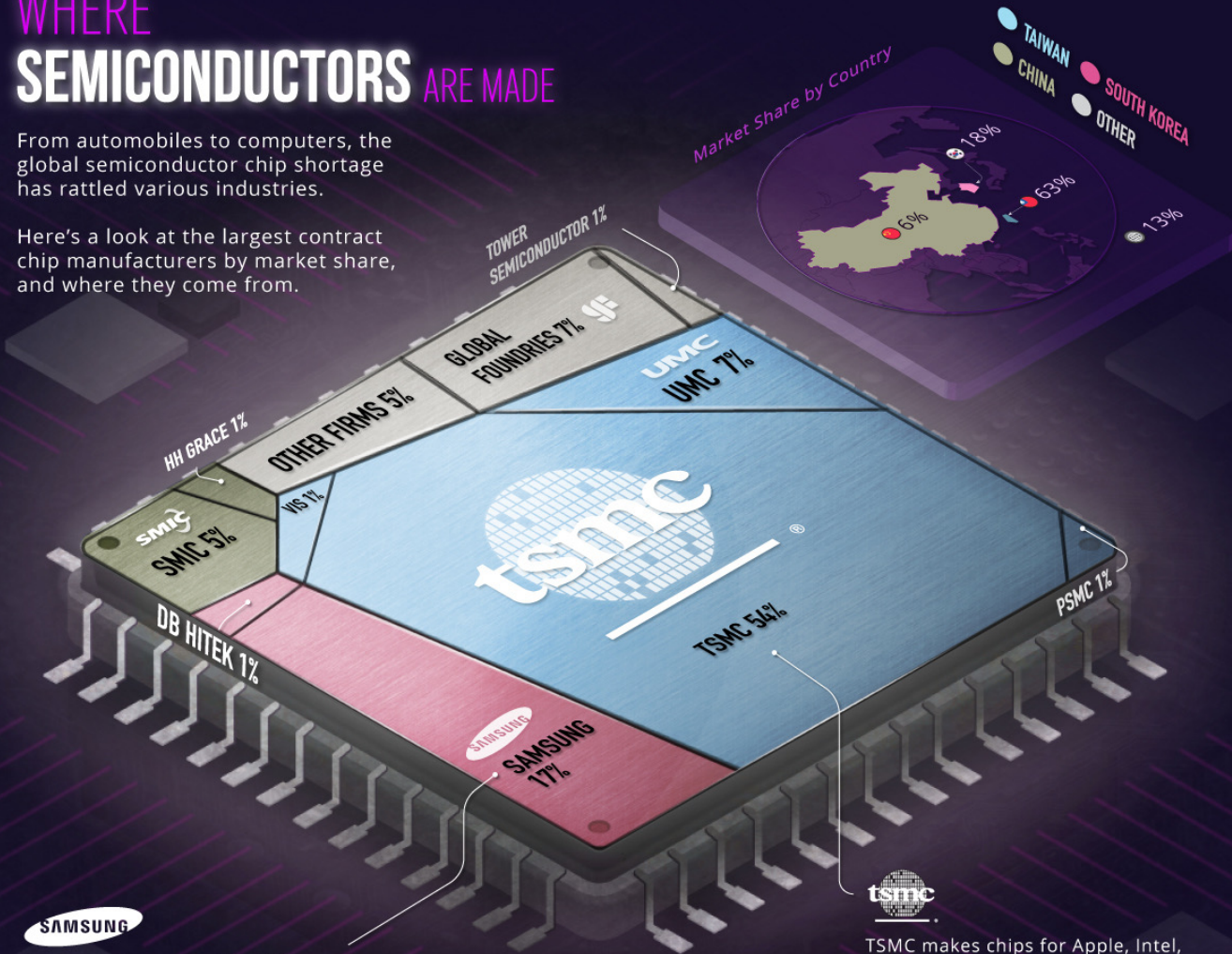
Source: Gartner



## WHERE SEMICONDUCTORS ARE MADE

From automobiles to computers, the global semiconductor chip shortage has rattled various industries.

Here's a look at the largest contract chip manufacturers by market share, and where they come from.

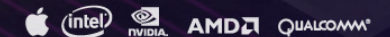


Samsung plans to build a \$17B semiconductor factory in Texas, aiming to begin operations by 2024.

Source: CNBC



TSMC makes chips for Apple, Intel, Nvidia, AMD, and Qualcomm.



Estimates suggest that TSMC accounts for >90% of the advanced processors market.

Source: Time

Source: Trendforce (March 2021)

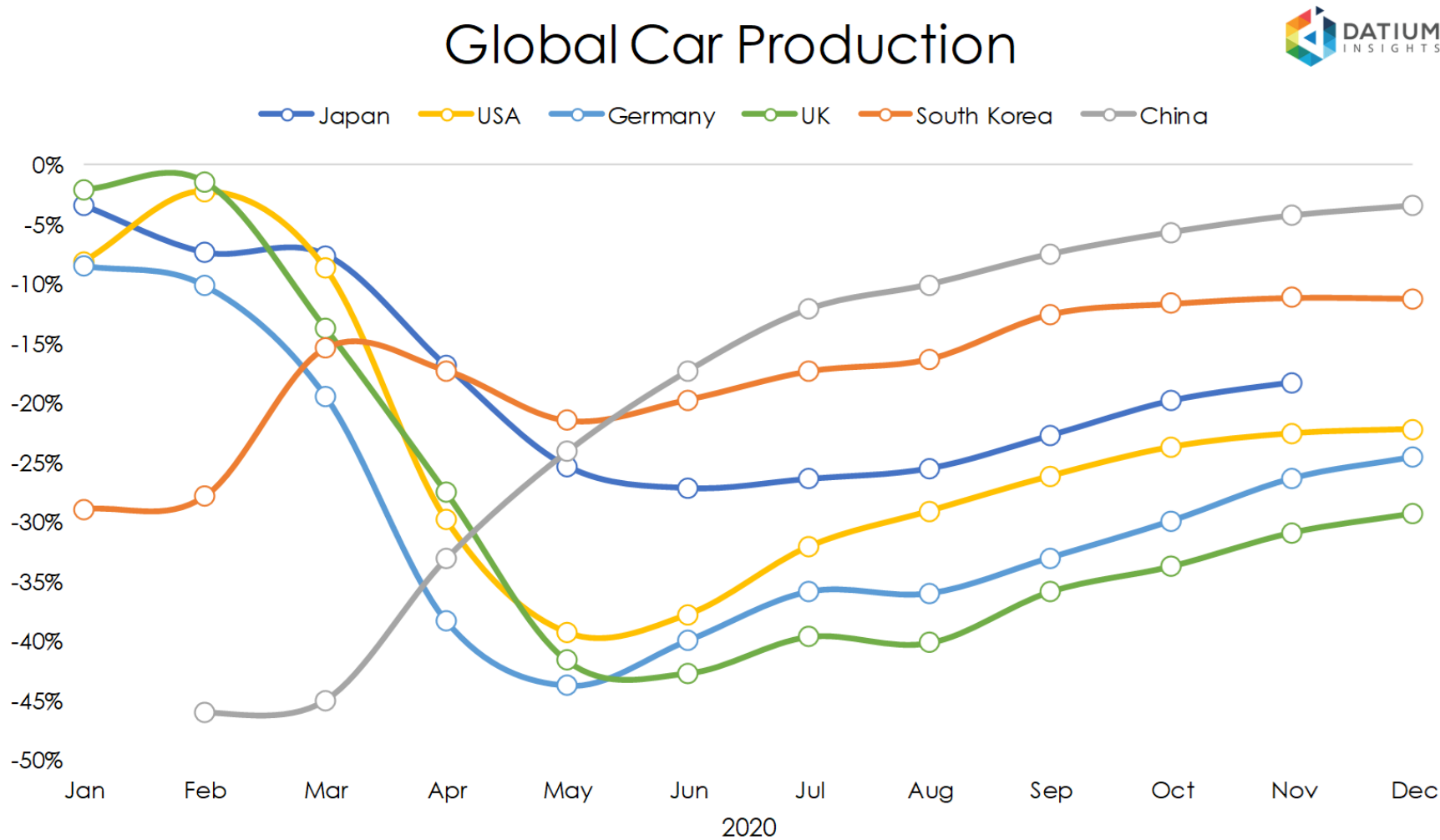


# Automotive Semiconductor Supply Chain



TSMC make up 54% and Samsung make up 17% of Manufacturing Production

# Did lower levels of production of semiconductors directly affect automotive production?



\*Source: Datium Insights, 2021 and Global Market Insights, 2022

## TOP 6 CHALLENGES OF THE AUTOMOTIVE INDUSTRY POST-COVID ERA





What key factors influenced disruptions in the automotive semiconductor supply chain?

Did response policies affect the semiconductor and automotive industries differently?

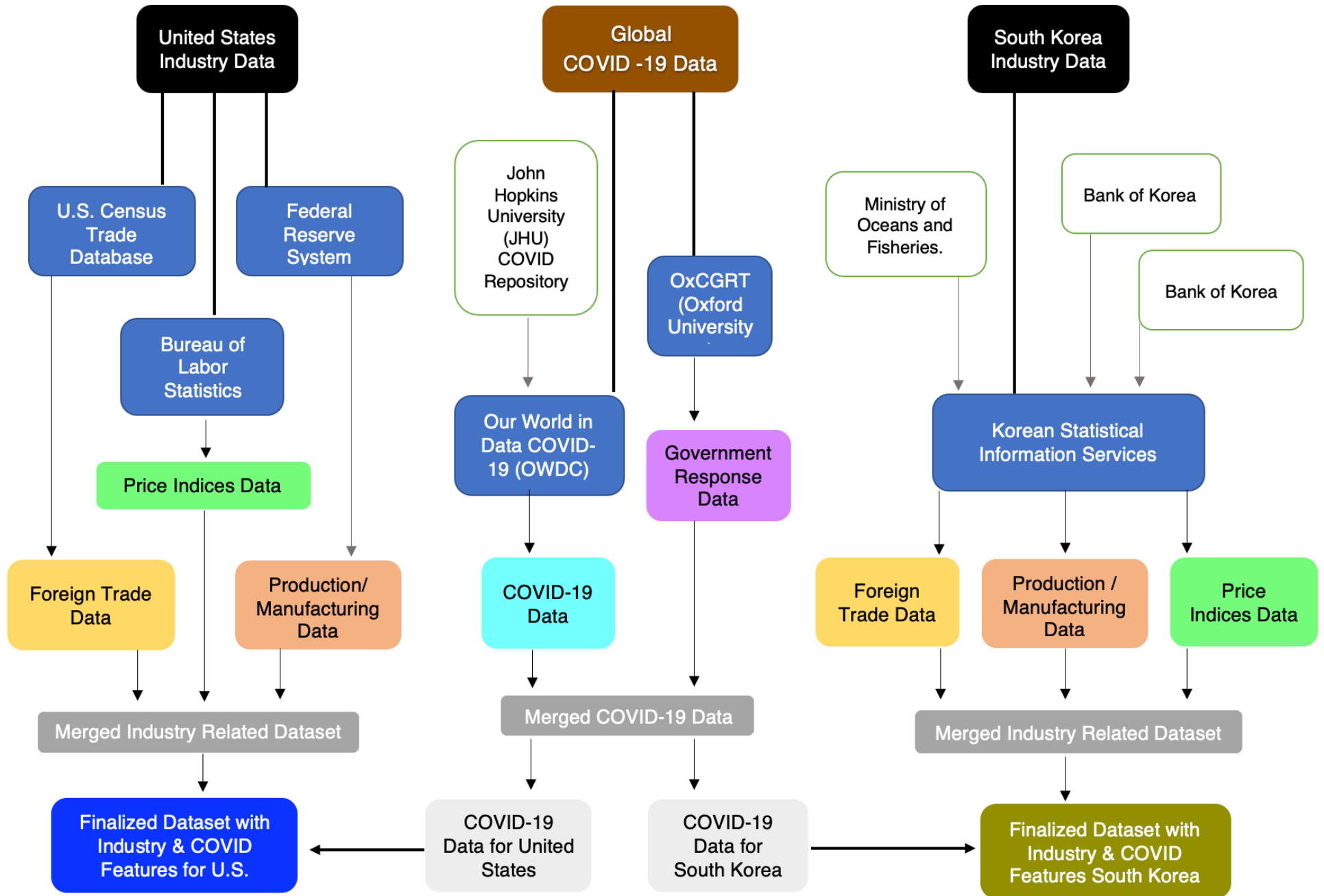
**Assumption:** COVID-19 response policies impacted production of semiconductors but did not impact production of motor vehicles.

Lockdown style restrictions affected the production of semiconductors in the United States but not in South Korea.



# Data Source & Preparation

Trade  
Production  
Price Indices  
Covid-19  
Government  
Response





# — Analysis:

Determine if covid features can predict trade, production, or price indices.

1

Use machine learning techniques to determine salient features for prediction.

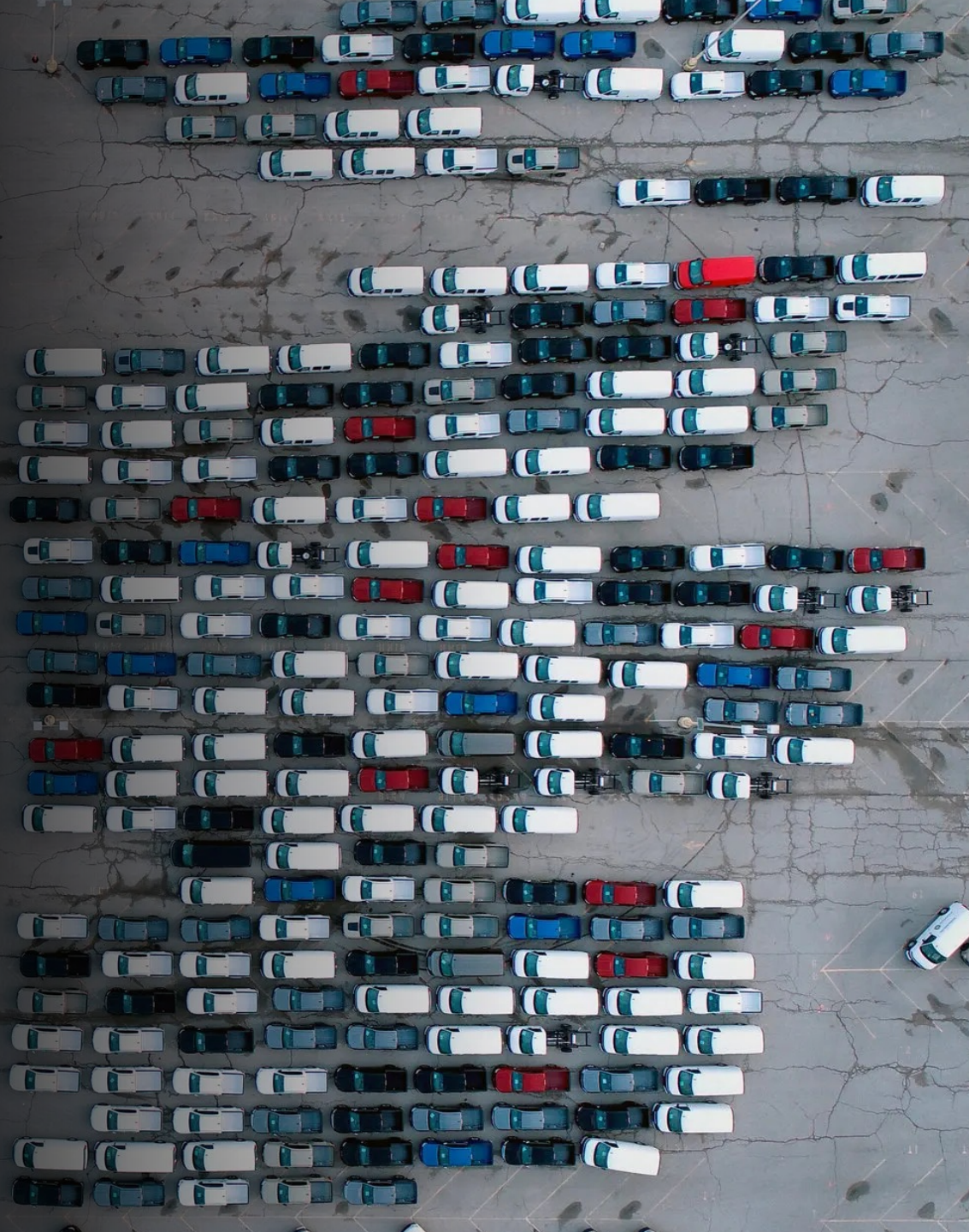
2

Use selected features in a GRU network for forecasting and future projections.

3

Apply projections to user-interface for government and industry use for future policy and decision making.

4



The background of the slide is a detailed, glowing green and blue circuit board pattern. The traces and components are intricate, creating a complex, maze-like appearance. The colors transition from dark blue to bright green, giving it a high-tech, digital feel.

# — Methods: Feature Selection

**Random Forest:** Ensemble Learning Method  
Using Multiple Decision Trees

**Support Vector Recursive:** Feature elimination  
method that uses SVM weights for ranking

**Regularized Regression:** Ridge and Lasso

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## Evaluation

**RMSE < 0.5 = Strong  
Predictability**

**Root Mean Square Error (RMSE):** Error metric that  
measures differences between predicted and observed values.

# Feature Selection Results:

## Semiconductors

Method and RMSE	USA			KOR		
	IP	ICAP	PPI	IP	ICAP	PPI
RF w/ Ridge	0.09	0.04	0.25	0.77	0.84	0.94
RF w/ Random Forest Regressor	0.21	0.16	0.46	0.39	0.08	0.83
Lasso	0.16	0.13	0.26	0.42	0.15	0.90
SVR	0.19	0.23	0.29	0.36	0.63	1.10

Random Forest (RF) with Ridge Regression best to predict for U.S. and with RF Regressor best to predict for South Korea.

\* **Industrial Production (IP)**: Volume of Production Output

\* **Industrial Capacity (ICAP)**: Resources at entity that enables production of goods.

Random Forest with Ridge Regression best to predict for Both U.S. and South Korea. Models could not accurately predict IP.

\* **Producer Price Index (PPI)**: Average change over time in selling price received by domestic producers for their outputs.

## Motor Vehicles

Method and RMSE	USA			KOR		
	IP	ICAP	PPI	IP	ICAP	PPI
RF w/ Ridge	1.86	0.37	0.09	0.78	0.49	0.11
RF w/ Random Forest Regressor	1.17	0.65	0.15	0.90	0.74	0.22
RF w/ Lasso	1.13	1.42	1.5	1.1	0.43	0.90

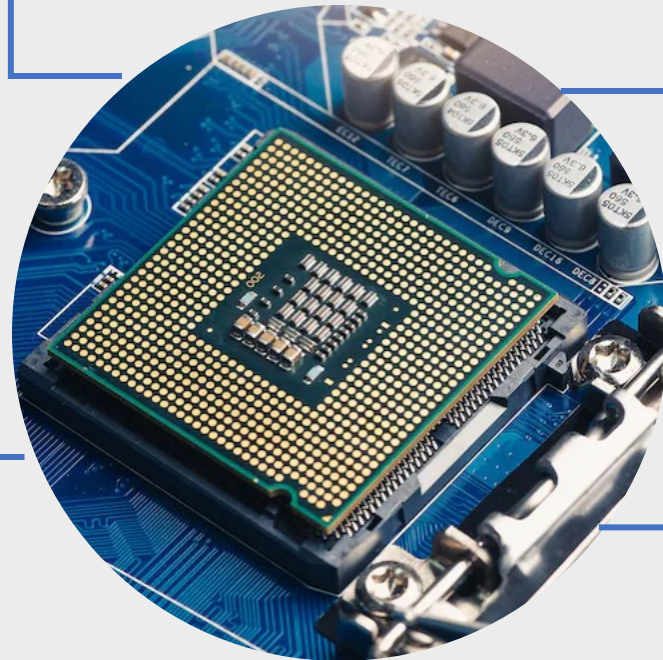
# Comparison of Selected Features

--- Features Selected ---	Semiconductor						Motor Vehicle						--- Features Selected ---
	USA Semiconductor			KOR Semiconductor			USA Motor Vehicle			KOR Motor Vehicle			
	IP	ICAP	PPI	IP	ICAP	PPI	IP	ICAP	PPI	IP	ICAP	PPI	
	8	10	6	12	9	4	5	10	10	8	9	14	
Exports MotorV													Exports Semi
Imports MotorV													Imports Semi
IP MotorV													IP Semi
CAPUTL MotorV													CAPUTL Semi
ICAP MotorV													ICAP Semi
PPI MotorV													PPI Semi
EPI MotorV													EPI Semi
IPI MotorV													IPI Semi
Total Cases													Total Cases
New Cases													New Cases
Total Deaths													Total Deaths
New Deaths													New Deaths
ICU Patients													ICU Patients
Total Tests													Total Tests
New Tests													New Tests
Positive Rate													Positive Rate
Total Vaccinations													Total Vaccinations
People Vaccinated													People Vaccinated
People Fully Vaccinated													People Fully Vaccinated
Total Boosters													Total Boosters
New Vaccinations													New Vaccinations
Stringency Index													Stringency Index
Government Response Index													Government Response Index
Containment Health Index													Containment Health Index
Economic Support Index													Economic Support Index

# Key Takeaway from Results

COVID Factors  
Can Predict:  
Production  
and Capacity of  
Semiconductors

COVID Factors  
Can Predict:  
Capacity of  
Motor Vehicles



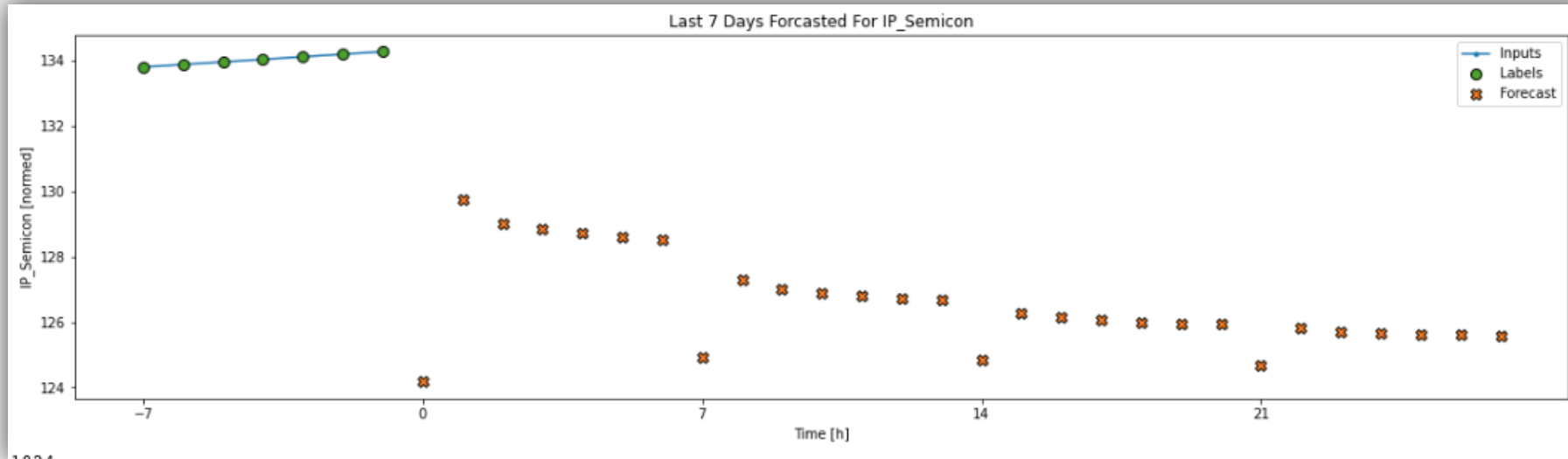
Response Policies:

- Not important for determining production and capacity of semiconductors

U.S. & Korea Comparison:

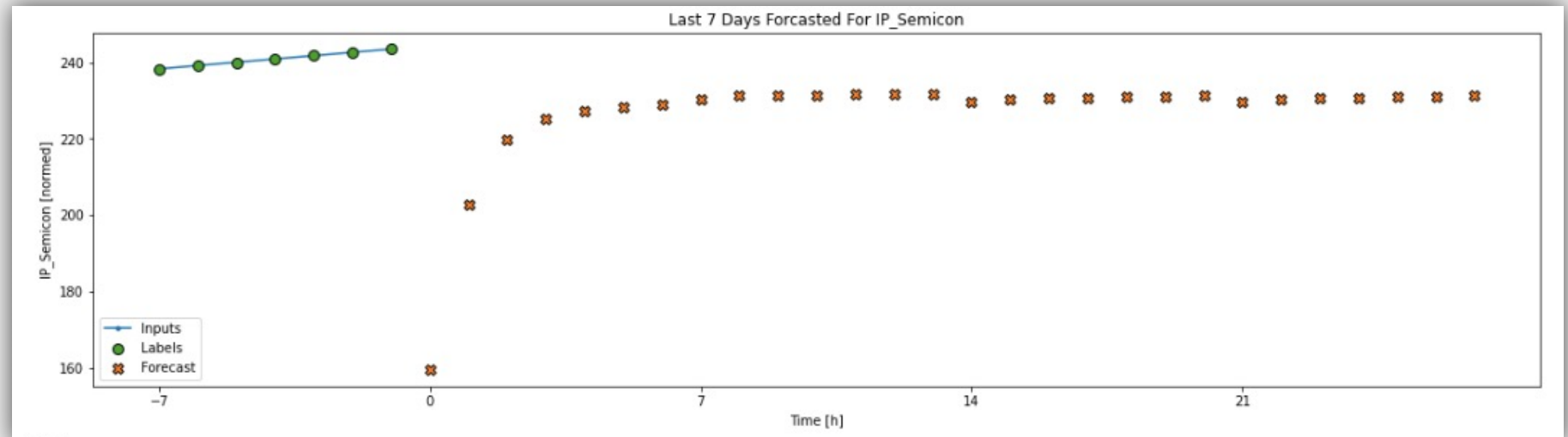
- Testing important for South Korea compared to U.S.
- Vaccinations important for both countries

# Forecasting and Projections



Semiconductor  
Production:  
United States

Semiconductor  
Production:  
South Korea

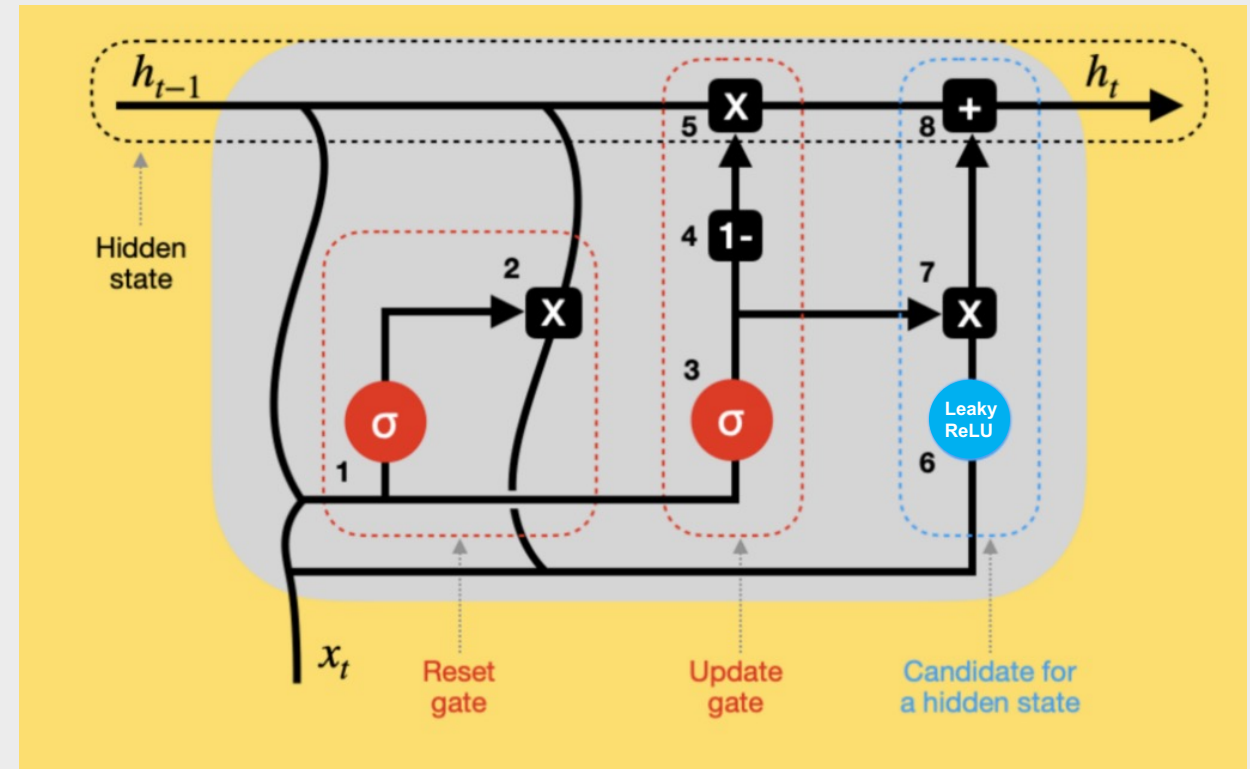


# GRU Autoregression Forecasting Model

- Models evaluated with Mean Absolute Error (MAE).

Mean Absolute Error (MAE) of Best Model			
	IP Semi-Conductor	ICAP Semi-Conductor	ICAP Motor Vehicle
USA	<b>0.29</b>	<b>0.16</b>	<b>0.08</b>
KOR	<b>0.38</b>	<b>0.20</b>	<b>0.56</b>

## Gated Recurrent Units (GRU) Neural Network





# Introducing SCDash

*(Semiconductor Diagnostic Accelerator & Supply-Chain Hub)*

- Dashboard & Datahub
- Forecasts COVID-19 affects on manufacturing production
- Automatically updates monthly production data across suppliers

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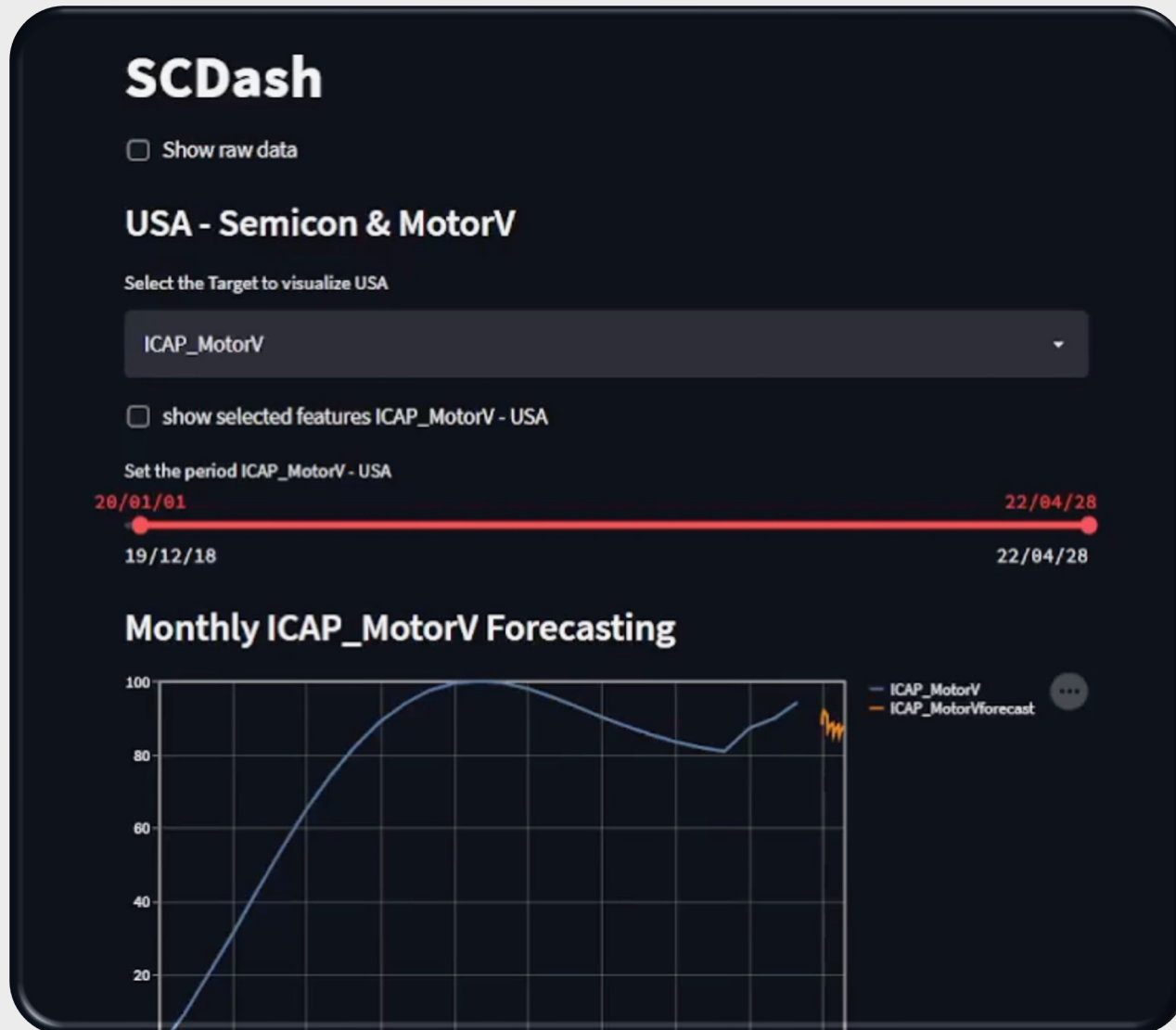
Data Synced through API

Private Company and Government Partnership

Collaboration between U.S. and South Korea



# Prototype and Interface



## Forecast Up to 28 Days into the Future

### Web-based Dashboard

- Real-Time Data
- Trends Over Time
- Alerts for production and manufacturing capacity

# Importance and Benefits

## End Users:

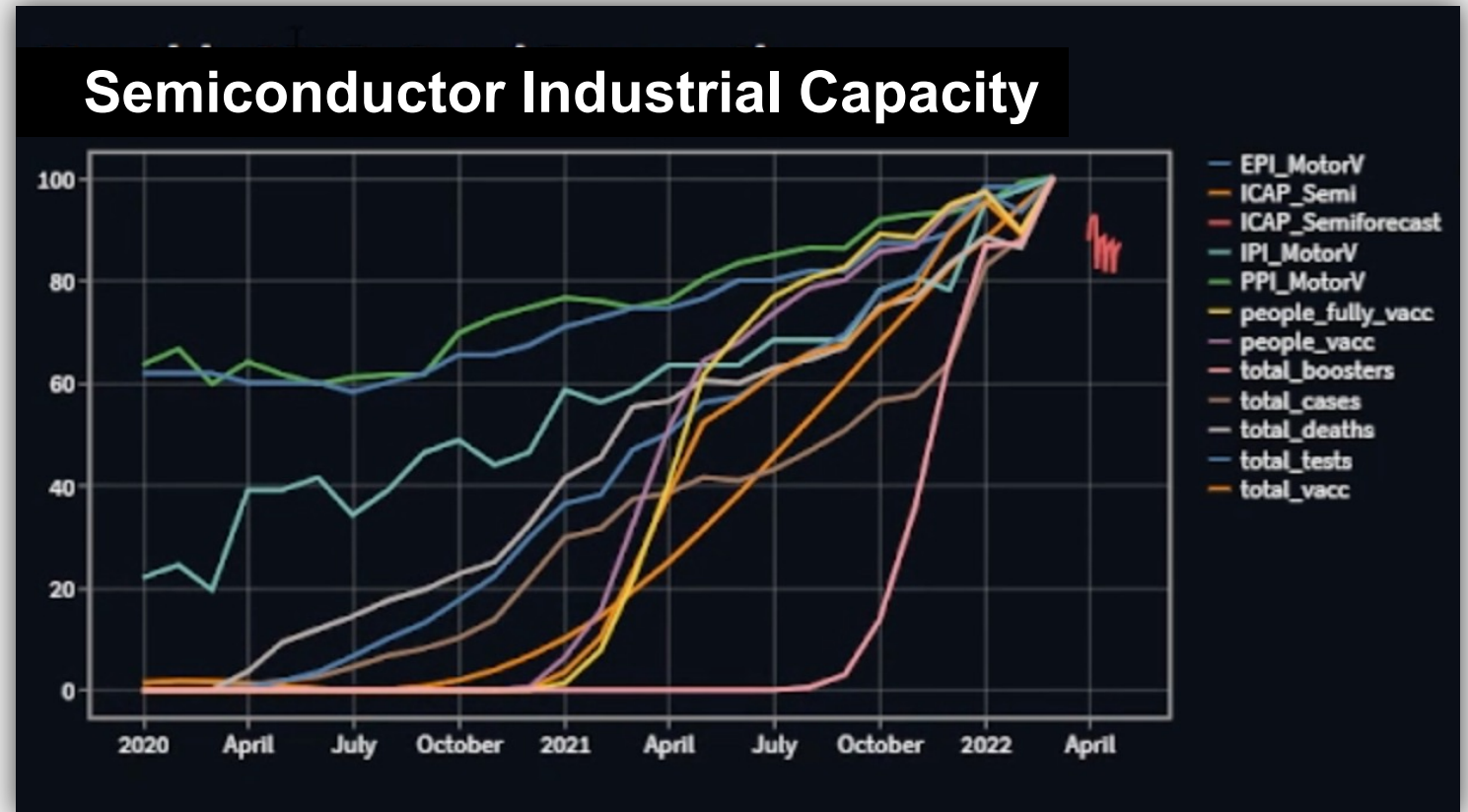
- Manufacturers
- Suppliers
- Governments

## Planning and Logistics:

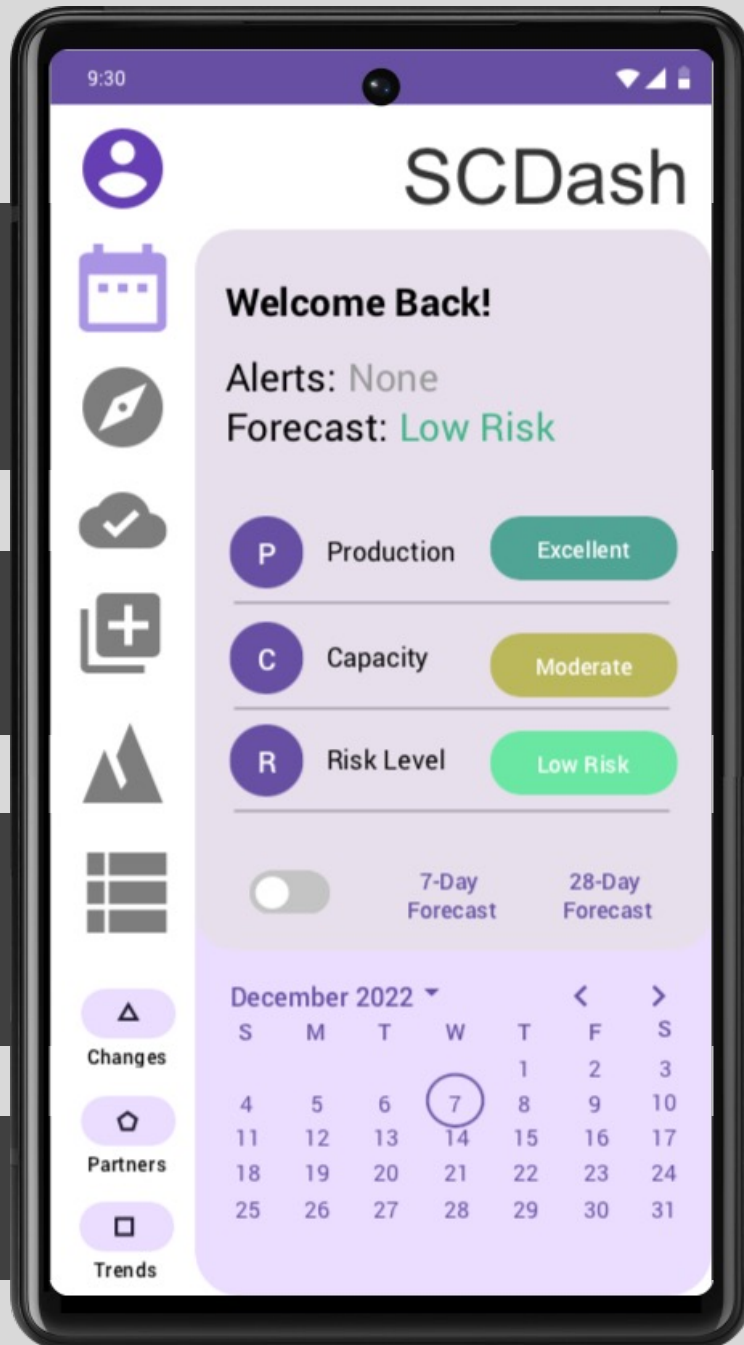
- Plan for Inventory
- Plan for Stockpile
- Better Business Strategies

## Technology Partnership:

Government & Private Companies  
Support for Small Businesses



# Conclusion



## Key Factors for Semiconductor Production and Capacity:

- United States: Vaccinations
- South Korea: Testing, Vaccinations

## Key Factors for Motor Vehicle Manufacturing Capacity:

- Both Countries: Production and Capacity of Semiconductors

## Policy Recommendations:

- Advocacy for vaccinations and continued funding for testing
- Financial support in semiconductor manufacturing

## Technology Partnership:

- Government and Industry Investment in SCDash

# Limitations

Workforce Data Not Considered in Model

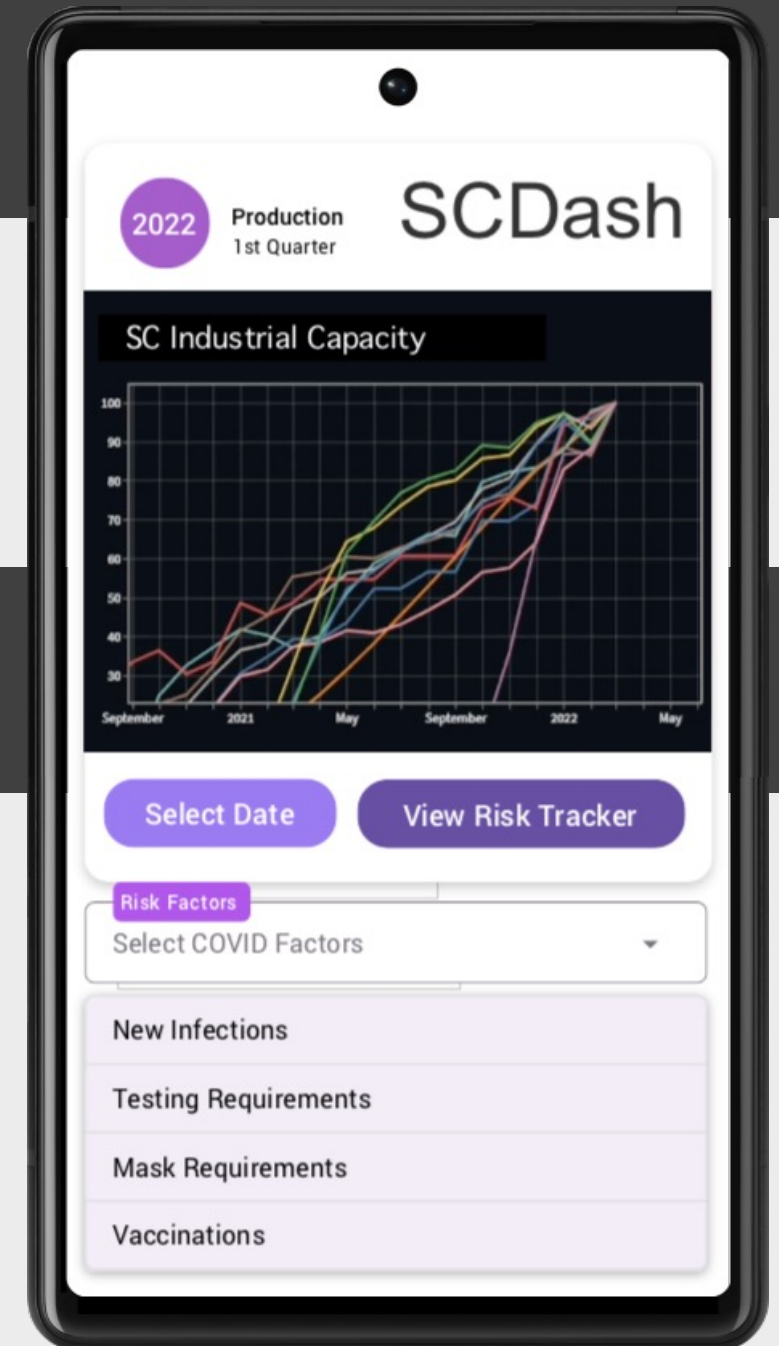
Time-Series Methods not applied for Regression

# Future

Expand models to predict more industries

Enhance Forecasting to all regions and countries

Develop SCDash to mobile application for wide-scale adoption and use.



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