



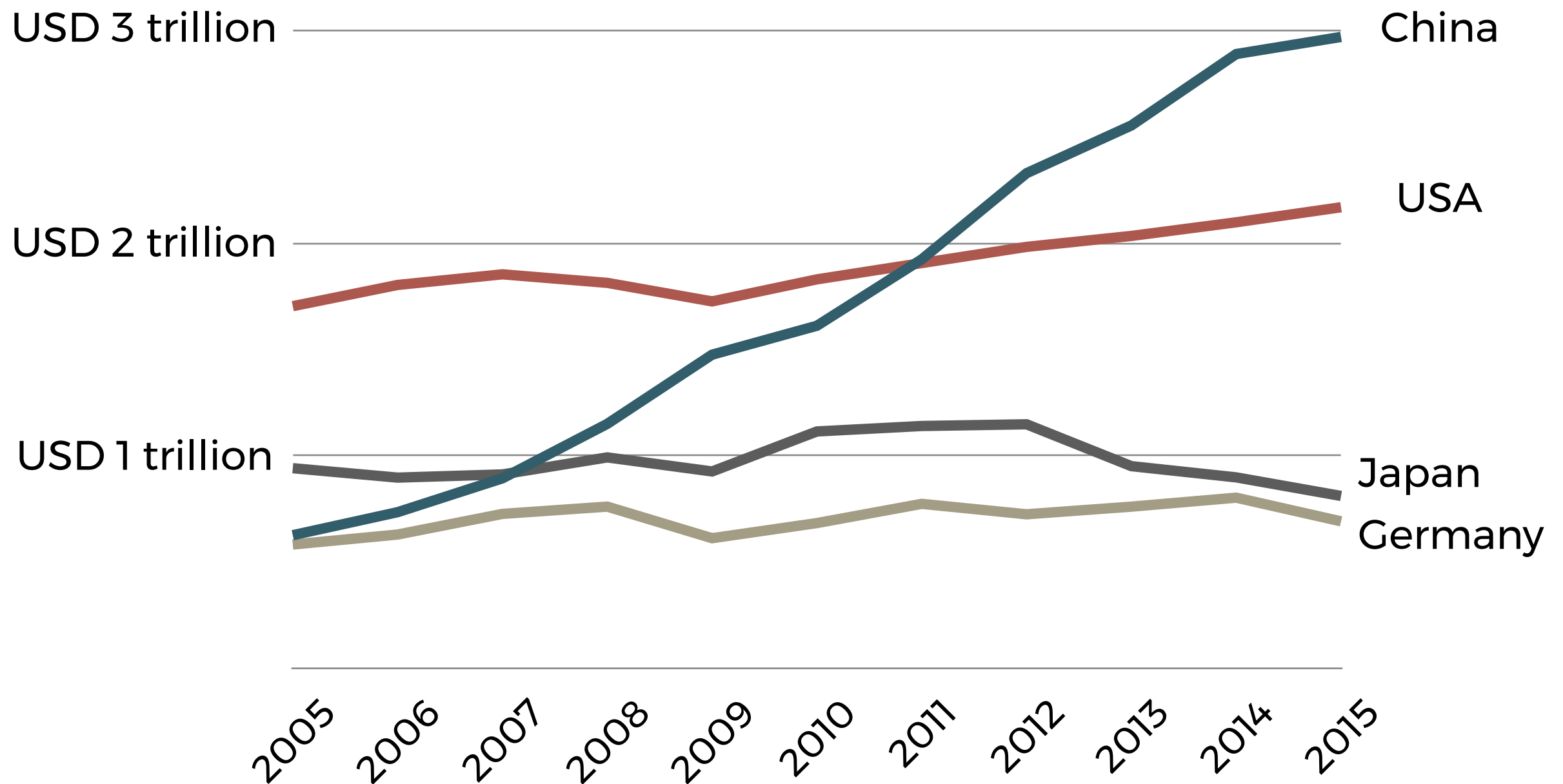
China's Specialization in Innovative Manufacturing

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Jonas Nahm, Johns Hopkins SAIS

1. **Indigenous Innovation Policy (2006-2020)**
2. Policy Implementation in Wind and Solar: “Innovative Manufacturing”
3. Made in China 2025 (2015-)

Manufacturing Value Added 2005-2015, by Country



Source: UN National Accounts Database, 2017

2006 Indigenous Innovation Policy

- Identified **11 key sectors for technology development**, including energy, transportation, and manufacturing
- Selected **8 technology fields**, with 27 technology breakthrough areas, including biotech, IT, advanced materials, lasers
- Chose **4 basic research programs**
- Bolstered funding for existing R&D programs by 20 percent annually
- Overarching goals:
 - Increase R&D expenditure to 2.5% of GDP by 2020
 - Basic research accounts for 15% of R&D spending by 2020
 - Radically reduce reliance on foreign technologies

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- Chose **4 basic research programs**
- Bolstered funding for existing R&D programs by ~20 percent annually
- Overarching goals:
 - Increase R&D expenditure to 2.5% of GDP by 2020
 - **2.1% in 2016**
 - Basic research accounts for 15% of R&D spending by 2020
 - **4.7% in 2013**
 - Radically reduce reliance on foreign technologies
 - **Use of standards, government procurement policies etc.**

2010 Strategic Emerging Industries (SEI)

- Identifies seven specific strategic emerging industries:
 1. Energy efficient and environmental technologies
 2. Next generation information technology (IT)
 3. Biotechnology
 4. High-end equipment manufacturing
 5. New energy
 6. New materials
 7. New-energy vehicles (NEVs)
- SEIs to account for 8 percent of GDP by 2015 and 15 percent by 2020
- Highlights importance indigenous innovation and R&D
- Calls on subnational governments to provide funding for “technology breakthroughs”

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團結 拼搏 務實 創新

BE UNITED GO ALL OUT STRESS REALISM AND BE INNOVATIVE

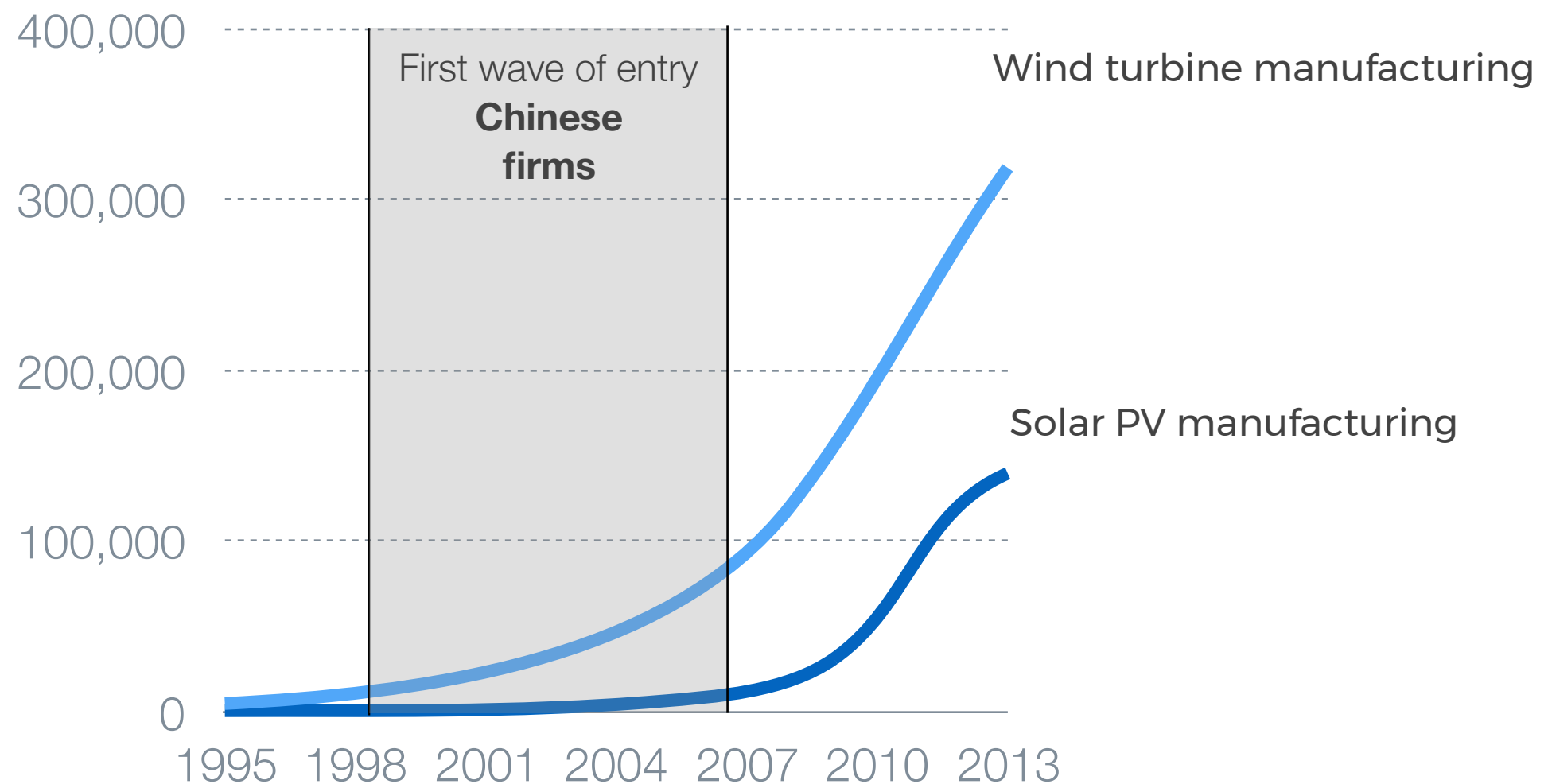


Chinese firms focus on innovative manufacturing

- Focus on commercialization: engineering and design capabilities at the intersection of manufacturing and traditional R&D
- Engineering capabilities that allow firms to simultaneously manage tempo, volume, and cost.
- Designated R&D teams that
 - **substitute materials** and components with lower-cost alternatives
 - **upgrade product designs** for manufacturability
 - **integrate new technologies** in products already produced at scale

Global networks supplied technology, not capabilities in mass production

Cumulative *Global* Wind and Solar PV Manufacturing (in MW)



Source: Earth Policy Institute, 2013.

“There was little reason to start from zero. Technology could be licensed, but manufacturing was not as simple. Early attempts were a terrible failure. Whole blades dropped off and the main shafts broke. It was really very dangerous.”

Wu Gang, founder of Goldwind

Source: Osnos 2009.

Firms repurpose *central* support

- Example: **Goldwind used 863 Program funds** not to replace foreign partners, but to improve capabilities in commercialization and scale-up.
- **Goldwind received 863 technology grants** for:
 - 600 kW turbine development in 1998 (licensed from Jacobs Energie)
 - 1.2 MW direct-drive turbine development in 2001 (licensed from Vensys)
 - 1.5 MW direct-drive turbine development in 2005 (licensed from Vensys)
 - 2.5 MW turbines in 2010 (joint development with Vensys)
 - 5 MW turbines in 2012 (joint development with Vensys)
 - currently, 10 MW offshore turbine development (joint development with Vensys)
- **Continued reliance on foreign partners**, focus on commercialization.

Local support for mass production

- **Legacy of mass production at the local level:**
 - Availability of trained staff
 - Engineering schools, vocational training, on-the-job training for manufacturing workers
 - Consulting services for mass manufacturing (permitting, construction)
 - “Complementary capabilities” - test centers, engineering work stations etc. depending on the needs of local industries
- **Financial incentives tied to production goals, revenue targets:**
 - Tax breaks, land deals, preferential loans

	USA	Germany	China
Wind turbine A			
Wind turbine B			
Wind turbine C			
Solar cell			
Solar component			

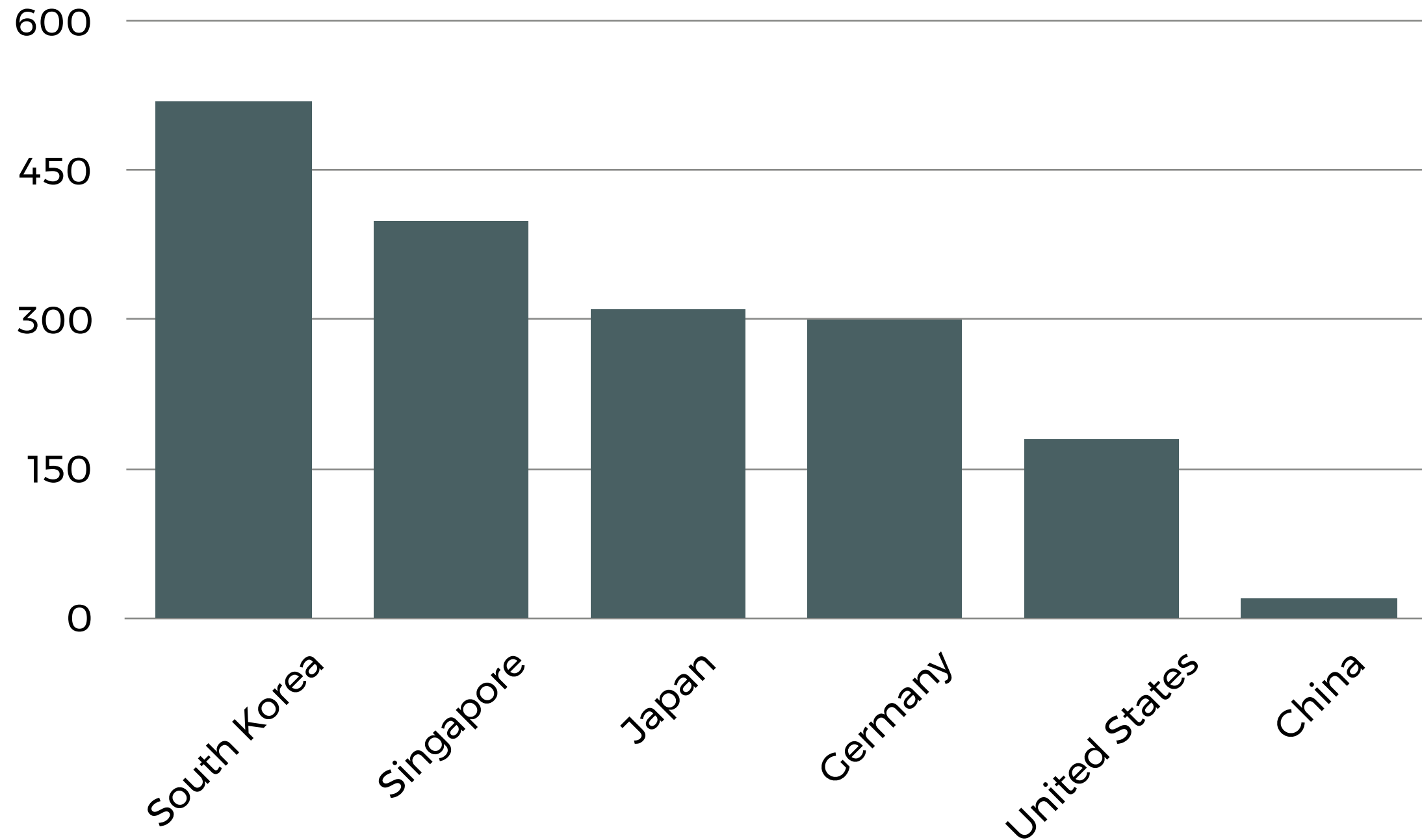
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Advanced manufacturing in China

- Industry 1.0: Mechanical Production
- Industry 2.0: Electrification, Mass Production
- Industry 3.0: Industrial robots, IT-based production
- Industry 4.0: Industrial Internet

**Advanced
manufacturing
in China**

Industrial Robots per 10,000 Workers, 2015



Source: IFR, MERICS

Made in China 2025

- Top-down policy framework
- Shift in focus from USA (Invention) to Germany, Japan (Industrie 4.0)
- Headed by the “Leading Small Group for Constructing a Manufacturing Superpower” - State Council and Ministries, in interaction with research institutes and industry groups.

Motivation:

- Urgent need for innovation-driven growth
- Concerns about the middle income trap
- Domestic industry squeezed between competition from developing and advanced economies

Made in China 2025

- 10 key technologies targeted:
 - New energy and energy-saving vehicles
 - Energy equipment
 - Agricultural machines
 - New materials
 - Biopharma and high-tech medical devices
 - New generation IT
 - **High-end CNC machines and robots**
 - Space and aviation
 - Maritime equipment and high-tech ships
 - Advanced railway transportation equipment

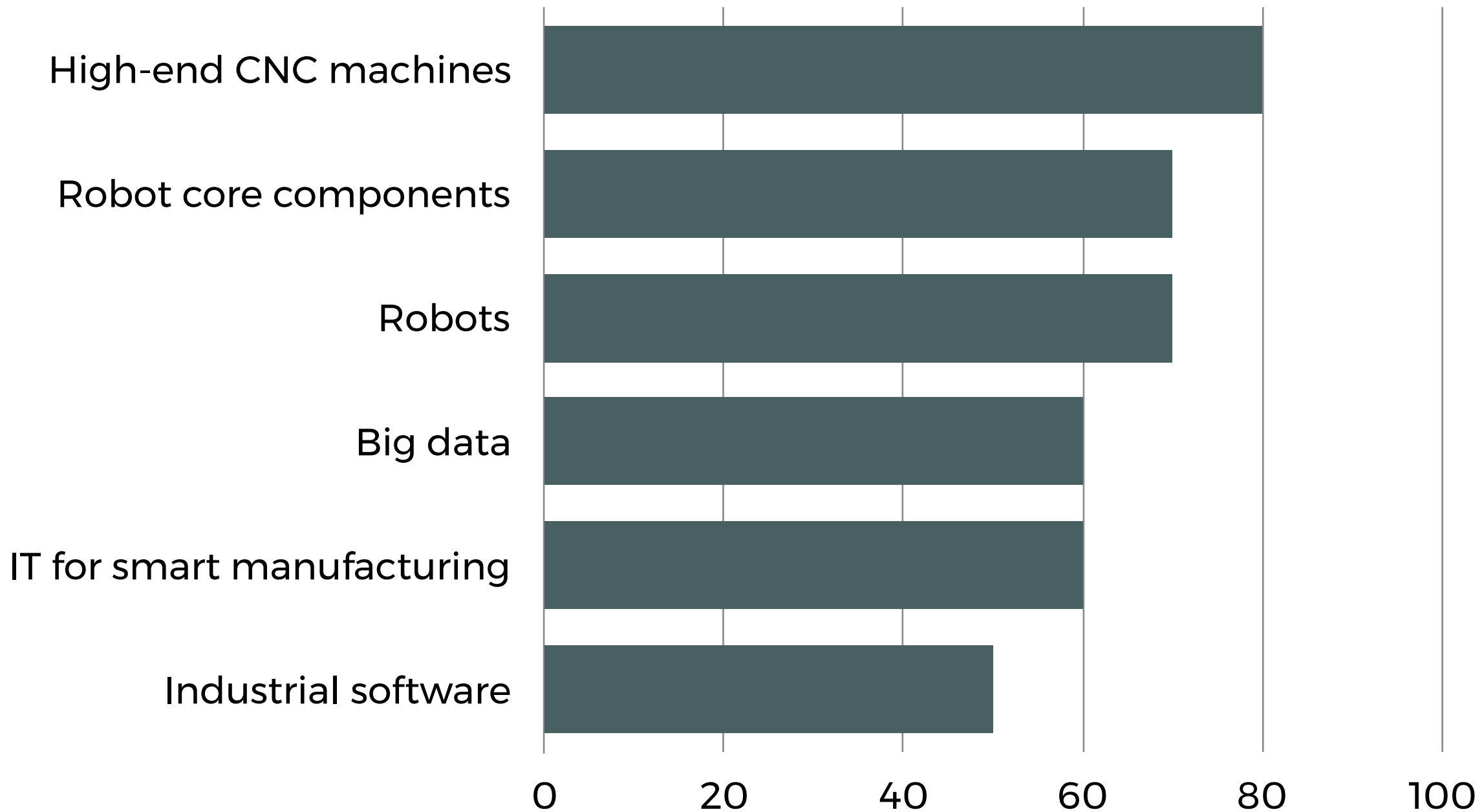
Focus on “promoting technological breakthroughs, service-oriented manufacturing, manufacturing-related service industries”.

Made in China 2025

Select Industrial Policy Targets

	2013	2015	2020	2025
Share of R&D spending of operating revenue (%)	0.88	0.95	1.26	1.68
Invention patents per 100 million CNY revenue	0.36	0.44	0.7	1.1
Broadband internet (penetration in %)	37	50	70	82
Digital design tools in R&D (penetration in %)	52	58	72	84
Use of numerical control machines (pen. in %)	27	33	50	64

2025 Goals for Domestic Market Share Chinese Smart Manufacturing Products



Source: MERICS

Made in China 2025

- 20 billion CNY (~3 billion USD) **Advanced Manufacturing Fund**
 - 6 billion CNY contribution from central government
 - 4 billion CNY State Development and Investment Corporation
 - 5 billion CNY Commercial Bank of China
 - Subnational governments also contribute
 - *First investments include EV manufacturer BYD (CNY 1.5 billion), Shanghai Robotics Consortium*
- Ministry of Industry and Information Technology to establish:
 - *40 Manufacturing Innovation Centers by 2025* using public and private funds, focus on creating domestic technologies
 - 2 are operational (additive manufacturing, batteries)
 - Enterprise-level experimentation projects (e.g. use of RFID in components, cloud platforms)
 - Pilot cities

Made in China 2025: Local Implementation

- Local governments have
 - Pledged to open 40 industrial parks for robotics development
 - Committed CNY 40 billion to subsidies, support for industrial robotics
 - Released local implementation plans focused on select industries, not all of which are related to the industrial internet and smart manufacturing

Made in China 2025: lessons learned?

- Shift away from focus on innovation-as-invention, but:
 - Top-down focus misaligned with enterprise skills
 - Lack of workforce training, human resources
 - Duplication of efforts at the local level
 - Short term planning horizon of local governments
 - **Continued focus on import substitution, techno-nationalism**



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