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Humanoid robotics: The road to real-world adoption -- the market size and ROI of four key applications


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What characterizes Humanoid Robotics in 2026 is the quick shift of focus from locomotion demonstration to commercial adoption (Exhibit 1). Previously, we analyzed the enabling technology progresses (see here) and the warehouse scenario (see here). In this note, we identify four key areas of adoption in the next five years, and show that their payback periods can soon fall below the 2.5-year threshold for accelerating adoption (Exhibit 5 to Exhibit 7). Combined, the four applications account for about half of our projected 1-million annual shipment in 2031 (Exhibit 11 and Exhibit 12). We also recommend a three-point formula for investors to track progress and pick winners.

Payback period. The four key applications are warehouse pick-and-place, factory material handling and inspection, urban and industrial patrol, and last-leg delivery to door (Exhibit 3 and Exhibit 4). These are the first to have reached or soon reach human performance levels. We analyze each application in China and the U.S. At currently available robot prices, the payback periods range from 1.0 (patrol in the U.S.) to 6.7 years (factory material handling and inspection in China) (Exhibit 5). Patrol in both U.S. and China already has payback below two years. In the other three applications, to achieve the 2.5-year payback, a typical threshold for accelerating adoption, humanoid robot prices would need to fall 30-50% from the current level in China (Exhibit 6) and 5-40% in the U.S. (Exhibit 7). Empirical evidence from the EV and battery industries shows that costs typically decline by 15-18% when volume doubles, with a much steeper curve at very small volumes (Exhibit 8). Therefore, we do not think robot pricing will remain a major hurdle for adoption in two to three years' time.

Potential market size. We deliberately leave other applications out of the scope of this note, such as installation and assembly in factories and almost all commercial and household applications. Those applications can potentially provide much bigger long-term TAM, and we have started to see proof-of-concept pilots, but we do not think they will become ready soon from a technology and ROI perspective (Exhibit 2). Across the four identified applications, our analysis suggests a potential market of approximately 10mn humanoid robots in China and 1mn in the U.S. (Exhibit 10). This is the potential "installed base". Factory material handling and inspection represents the largest opportunity. Further assuming an 8% replacement by 2031 (the "penetration ratio"), we derive an annual shipment of ~500k units in 2031 (Exhibit 11), accounting for ~50% of the humanoid robot market size we project in that year.

Picking winners. To identify front-runners embracing these first wave commercial opportunities, we recommend investors to track **three trajectories** of individual robot makers: 1) growth trajectory of real commercial sales and verifiable expansion of commercial customers, 2) performance improvement trajectory by using deployment data to close the reinforcement learning loop (rather than just the amount of data), 3) a trajectory moving toward the center of the industry ecosystem, and early evidence of "system integrators" gathering around certain robot makers (see here).

See the Disclosure Appendix of this report for required disclosures, analyst certifications and other important information. Alternatively, visit our Global Research Disclosure Website.

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DETAILS

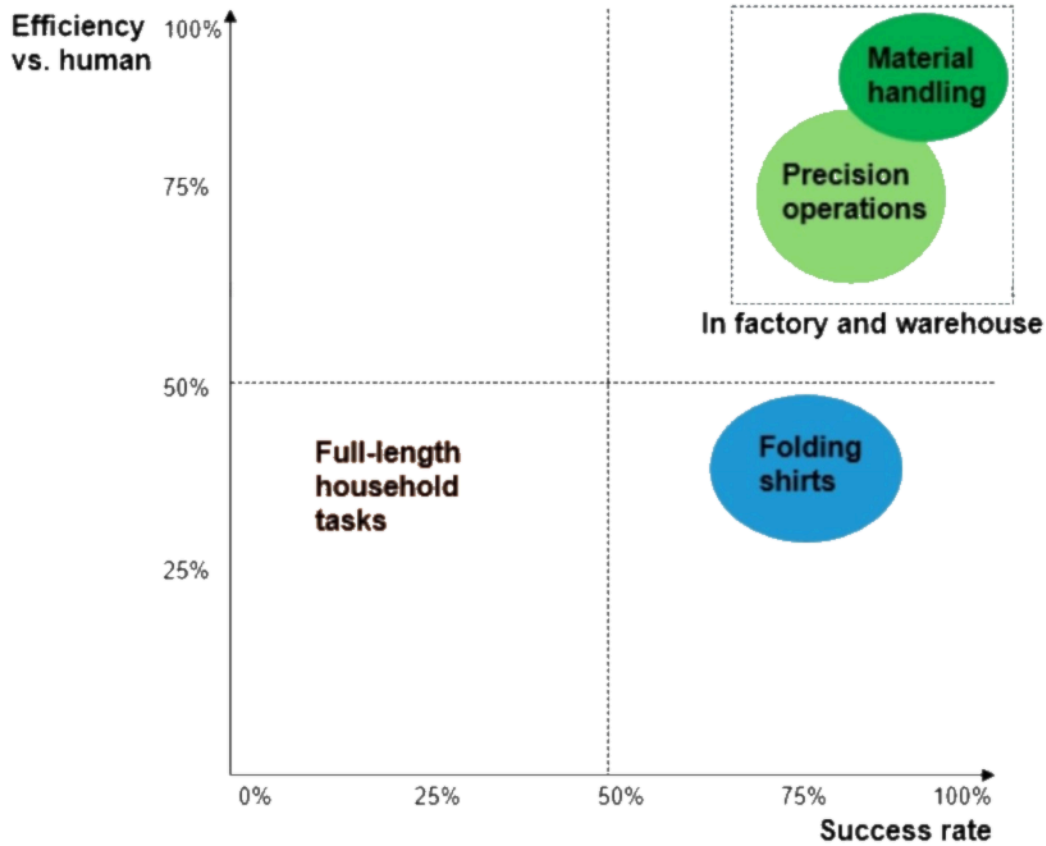
SUMMARY

EXHIBIT 1: **The Humaniod Robotics industry is shifting from locomotion demonstration to commercial adoption**

Company	Robot	Est. price	Customer	Start time	Industry	Task	Note
Boston Dynamics	**Stretch**	$150,000	NFI, DHL, etc.	2022	Warehouse	Unload and upload boxes	1) Moved over a million customer boxes in under a year at multiple sites, **up to 700 cases per hour**; 2) **Wheeled design with gripper arms (7 DoF), vision systems, and dedicated safety system;** 3) Gripper with sensing tech and pneumatic control
Boston Dynamics	**Atlas**	$150,000	Hyundai and Google DeepMind	2026	Automotive and tech	TBD	1) Deployment scheduled in 2026; 2) Learned behaviors can be redeployed across fleets
Agility	**Digit**	$250,000	GXO, Amazon, Mercado Libre, Schaeffler, Toyota, etc.	2024	Warehouse	Move a tote from an AMR to a conveyor	1) **98% accuracy** and 100k+ totes moved with GXO; 2) Over 65k hours work; 3) Units per hour lower than human; 3) **75% components sourced in the US**
Figure	**Figure 02**	$130,000	BMW	2025	Automotive	Load sheet-metal into welding fixtures	1) 10-hour shifts Mon to Fri: 90,000+ parts loaded, 1,250+ runtime hours, contributed to 30,000+ BMW X3 vehicles 2) KPIs including **cycle time, placement accuracy (balancing speed with precision), and interventions** 3) Critical data generated for Figure 03 design
Figure	**Figure 03**	$130,000	BMW	2026	Automotive	Pick components up and sort them into a sequencing trolley	1) Improved **hands with tactile sensors and palm cameras;** 2) Enhanced safety, wireless charging, audio functions;
Apptronik	**Apollo**	N/A	Mercedes-Benz	2025	Automotive	Assemble kits and deliver p	1) First trained by teleoperation with the goal of autonomous working; 2) 25kg payload capacity
Unitree	**G1/H2**	$12,000 /$28,000	NIO, Geely, Schneider	2024	Automotive, Electrical equipment	Assemble parts, patrol, and conduct inspections	1) **High success rates for simple tasks**, but lower success rates for long-sequence tasks involving 10-20 steps and small parts; 2) **Customers can customize the payload**
Agibot	**G2**	$85,000	Longcheer	2025	Electronics	Pick and place the tablet into the testing fixture	1) **Capable of performing the work of one operator across two daily shifts;** 2) **>99.5% overall success rate;** 18-20 sec per process: up to 310 units/hour throughput; 3) **Wheeled design**
UBTECH	**Walker S**	$138,000	11 companies incl. BYD, Geely, Foxcon, SANY	2024	Automotive, electronics, machinery	Six tasks incl. box handling, SPS sorting, quality inspection, screw tightening, part installation, and process material handling	1) On-time over **10k hours** in Zeekr factory; 2) **3-minute autonomous battery swap;** 3) Failure rate <0.5%; 4) 15kg payload
Robotera	**Star 1/L7**	$40,000-$60,000	SF Express	2025	Warehouse	Sort parcels	1) **90% human efficiency in certain applications ; 2) 95% accuracy**
Leju	**KUAVO**	N/A	STEP, Hongqi Auto, etc.	2025	Automotive, machinery	Load boxes, handle materials, and conduct inspections	1) Over 100 units delievered in factories; 2) 50% human efficiency at the beginning of 2025
Galbot	**S1**	$140,000	CATL	2026	Battery	Load materials	**Wheeled design** with dexterous hands
Xiaomi	**N/A**	N/A	Xiaomi	2026	Automotive	Load materials	Tested for **four months,** achieving over **90% success rates** across multiple tasks (self-tapping nut assembly,console side panel installation, and bin folding)

Non-exhaustive: we have selected major industrial use cases from humanoid companies in both USA and China. Boston Dynamics is owned by Hyundai (not covered) and UBTECH and Unitree are public (not covered). Xiaomi is covered by Bernstein Asian Autos team. Agility agreed to go public through a merger with the SPAC Churchill Capital Corp XI. Other companies mentioned in the list are private.
Source: company websites, industry news, AlphaSense, Bernstein analysis

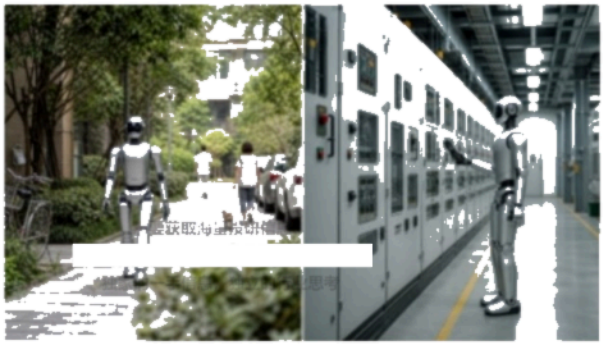
EXHIBIT 2: **Factory and warehouse applications are the first to reach human performance levels**



Source: Physical Intelligence, "Task adaptation of Vision-Language-Action model: 1st Place Solution for the 2025 BEHAVIOR Challenge" by Larchenko and etc., industry news, Bernstein analysis

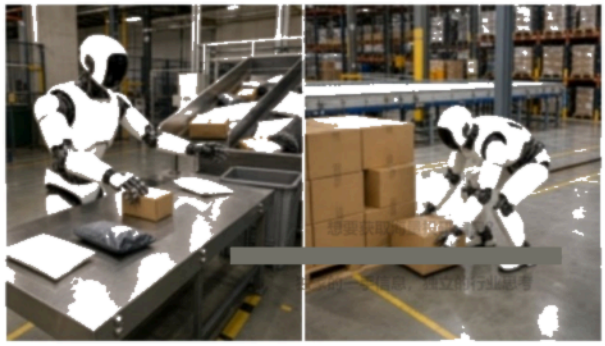
EXHIBIT 3: **We analyze four key areas of adoption in the next five years (Illustrative pictures generated by Perplexity; pilot/deployment projects listed below the pictures)**

Patrol: urban and industrial



Unitree G1/H1, LimX Tron-1 (multi-modal biped)

Warehouse ops incl. sorting and handling



Agility Digit, Boston Dynamics Stretch, Robotera Star 1/L7

Delivery to door (one robot paired with one courier, each serving one building)



Amazon is reportedly testing solutions that pair a robot with a courier to serve different buildings

Factory: material handling and inspection



Figure 02/03, Apptronik Apollo, Agibot G2, UBTECH Walker S, Leju KUAVO, Galbot S1, Unitree H2, Xiaomi

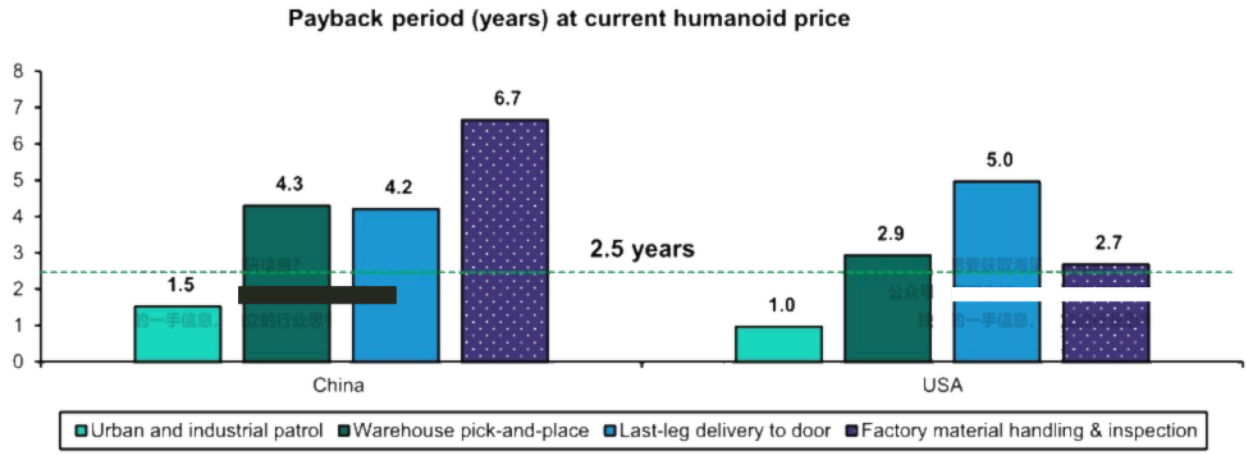
Non-exhaustive: we have selected major industrial use cases from humanoid companies in both USA and China. Boston Dynamics is owned by Hyundai (not covered) and UBTECH and Unitree are public (not covered). Xiaomi is covered by Bernstein Asian Autos team. Agility agreed to go public through a merger with the SPAC Churchill Capital Corp XI. Other companies mentioned in the list are private.
Source: pictures generated by Perplexity referencing real-world pilot cases, Bernstein analysis

EXHIBIT 4: **Payback period is calculated by the "pay" (upfront investments) divided by the "back" (annual net savings)**

Activities		"Pay" (upfront investments)	"Back" (annual net savings/earnings)	
			Gross savings/earnings	Supporting costs
Patrol	Urban and industrial incl security checks, meter reading, and power line inspection, etc.	**1) Robot procurement costs** $25k and $75k for patrol and delivery in China and U.S. $65k and $150k for warehouse and factory in China and U.S.	3.8 substituted labor per robot considering both productivity and working hour difference	**1) Robot maintenance and electricity costs** (15% of robot price annually; 10% for "agv+cobot" solution)
Warehouse	Sorting, handling, etc.	**2) Robot integration costs** 30% of robot price for humanoids 40% of robot price for "agv + cobot" solution	2.8 substituted labor per robot	**2) Added operator costs** (2-5 humanoids looked after by 1 operator)
Delivery to door	Last-leg package delivery to door		**U.S.:** 1.3 substituted labor per robot assuming pairing each robot with a courier **China:** Doorstep delivery by robots generates an additional 2 RMB per order than delivery to stations or parcel lockers	
Factory	Material handling and inspection		2.4 substituted labor per robot	

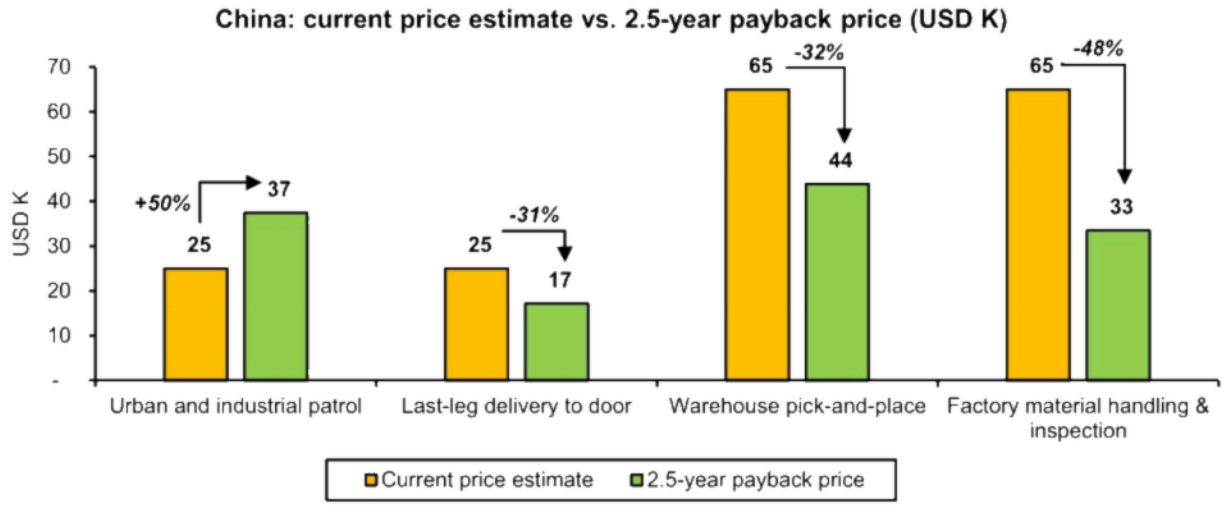
Source: Bernstein analysis

EXHIBIT 5: **At currently available robot prices, the payback periods range from 1.0 (patrol in the U.S.) to 6.7 years (material handling and inspection in China)**



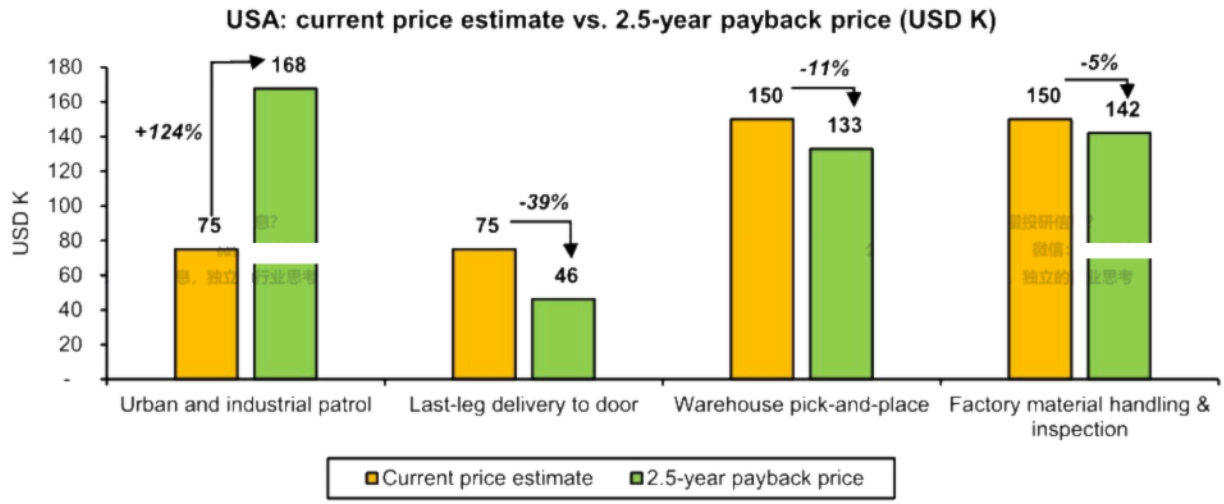
Source: company filings, company news, Bernstein analysis and estimates

EXHIBIT 6: **Patrol already has payback below two years. In the other three applications, to achieve the 2.5-year payback, a typical threshold for sharply accelerating adoption, humanoid robot prices would need to fall 30-50% from the current level in China**



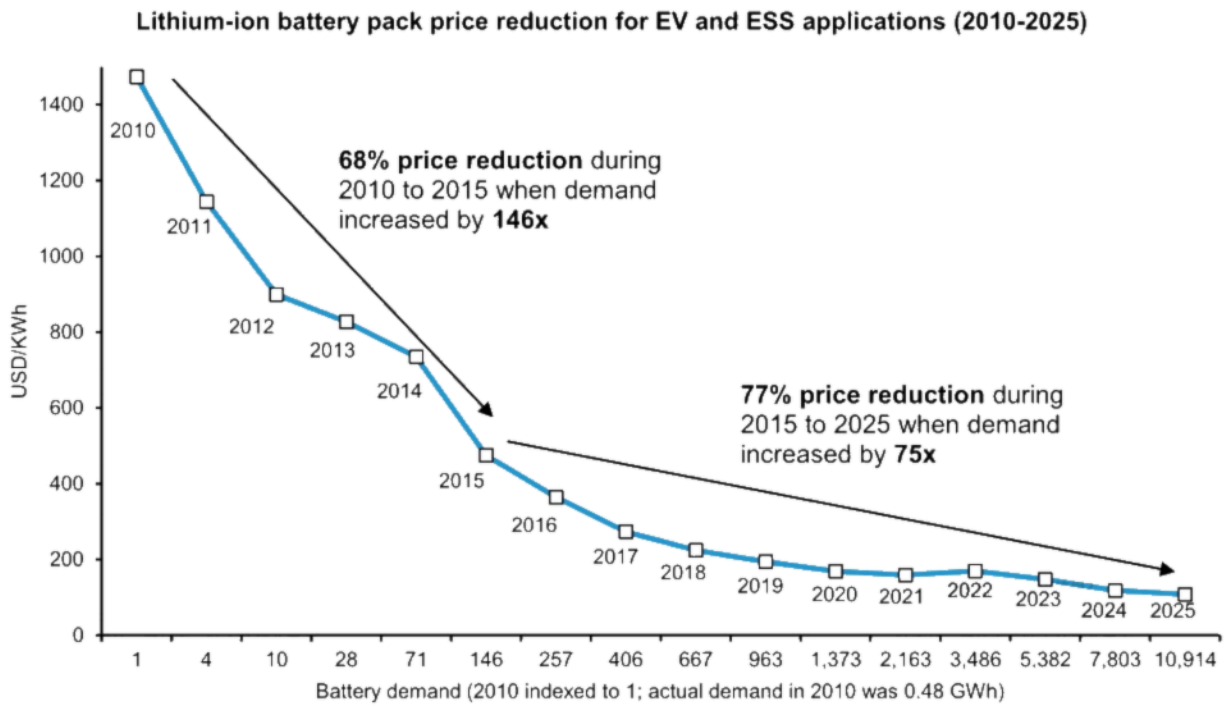
Source: Bernstein analysis and estimates

EXHIBIT 7: **Patrol already has payback below two years. In the other three applications, to achieve the 2.5-year payback, a typical threshold for sharply accelerating adoption, humanoid robot prices would need to fall 5-40% from the current level in the U.S.**



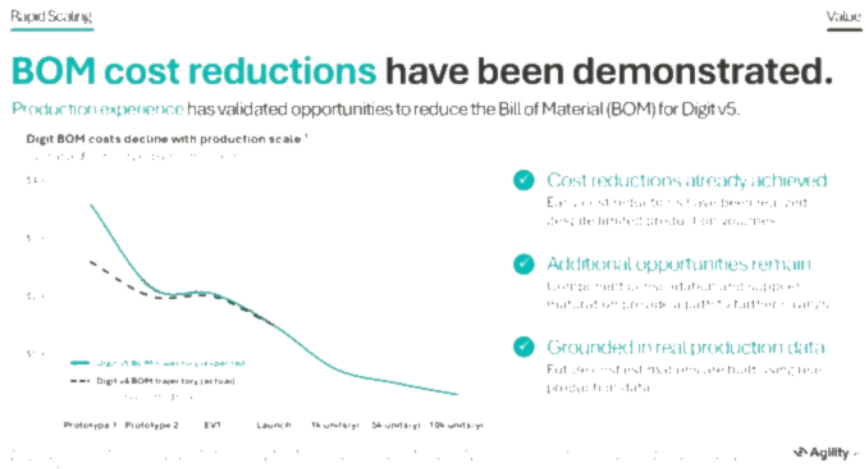
Source: Bernstein analysis and estimates

EXHIBIT 8: **Empirical evidence from the EV and battery industries shows that costs typically decline by 15-18% when volume doubles, with a much steeper curve at very small volumes**



Source: Bernstein's Global Energy Storage team, BlommbergNEF

EXHIBIT 9: **Similarly, Agility and other major humanoid players expect significant cost reductions as production scales**



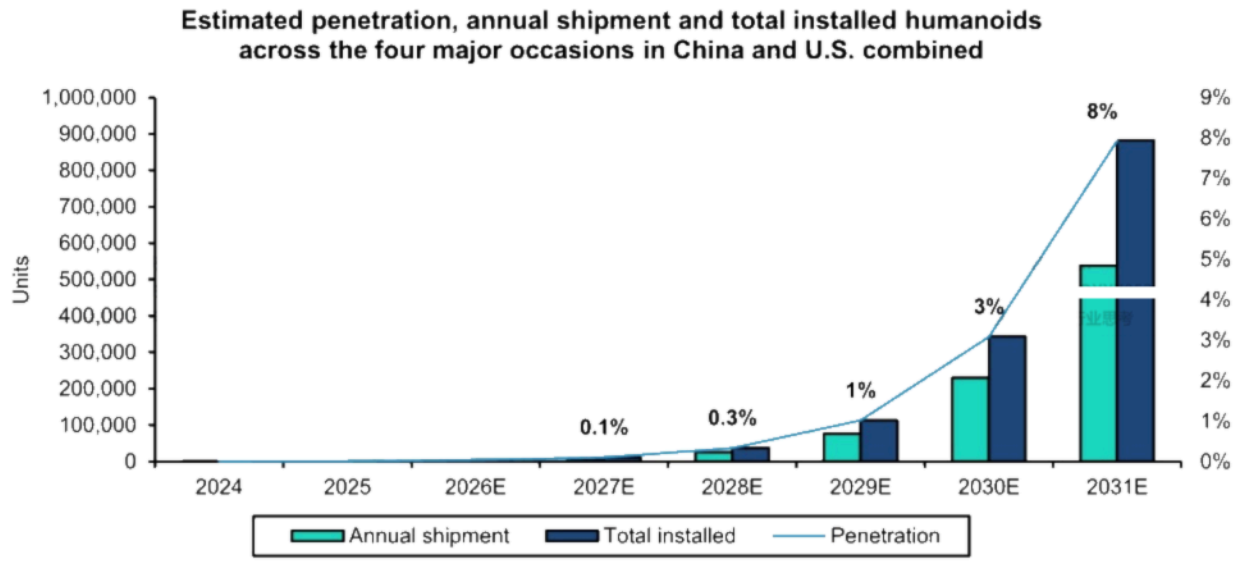
Source: Agility (June 2026 investor presentation), Bernstein analysis

EXHIBIT 10: **Across the four applications, our analysis suggests a potential market of approximately 10mn humanoid robots in China and 1mn in the U.S. Factory material handling and inspection represents the largest opportunity**

	No. of robots (Mn)		= No. of workers (Mn)		X % Addressable		X Substituted labor per robot	
	China	USA	China	USA	China	USA	China	USA
Urban and industrial patrol	1.8	0.0	6.8	0.2	100%	100%	3.8	3.8
Warehouse pick-and-place	0.5	0.1	1.4	0.4	90%	90%	2.8	2.8
Last-leg delivery to door	1.6	0.4	3.4	1.0	50%	50%	1.1	1.3
Factory material handling & inspection	6.0	0.6	17.1	1.8	85%	85%	2.4	2.4
Total	**9.9**	**1.2**	**28.7**	**3.5**				

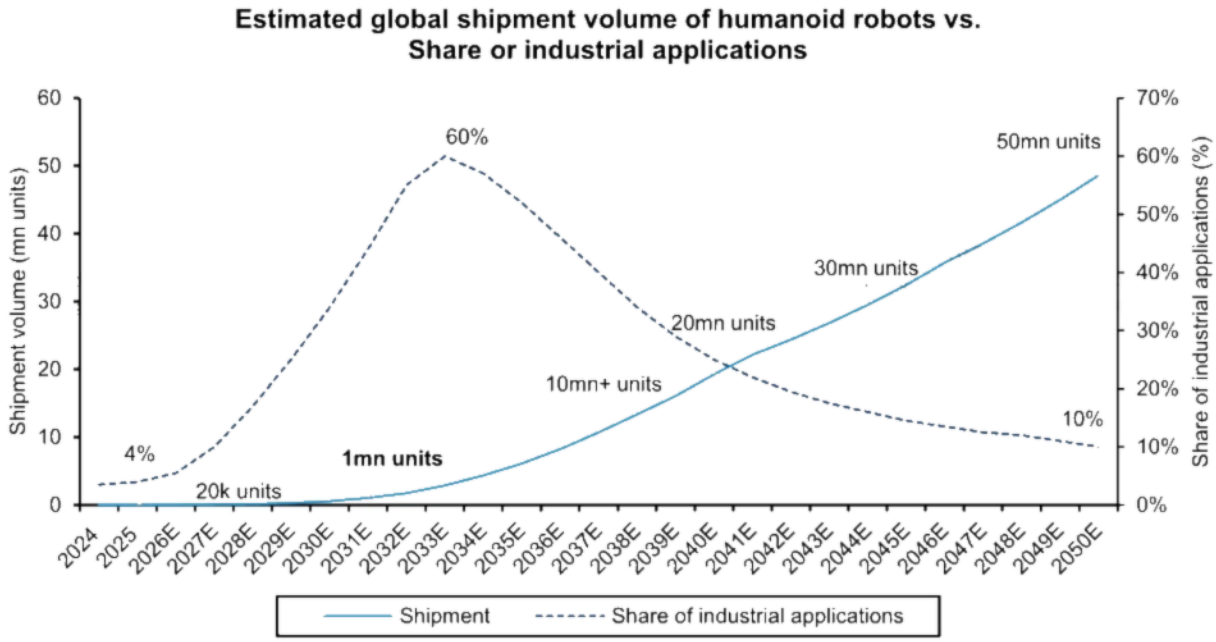
Our key assumptions are color coded in red.
Source: Bernstein analysis and estimates

EXHIBIT 11: **We estimate that these four use cases will achieve ~8% penetration over the next five years, reaching an installed base of ~900k units and annual shipments of 500k+ units by 2031**



Source: Bernstein analysis and estimates

EXHIBIT 12: **Near-term adoption concentrates on industrial applications and the four applications will account for ~50% of the humanoid robot market size in 2031**



Source: Bernstein estimates and analysis

DETAILED PAYBACK ANALYSIS

The charts below illustrate our payback analysis and the sensitivity of payback periods to robot prices. In each scenario, payback period is calculated as upfront humanoid investment divided by annual costs saved after deployment or annual net earnings. We have translated all figures in USD. Five major observations:

1) **Current payback periods** range from **1.0 to 6.7 years**.

2) Despite higher robot prices, **the U.S. generally offers faster payback than China** because labor costs are typically 3-5x higher.

3) Among the use cases analyzed, **patrol delivers the most attractive economics** in both markets (<2 years payback) driven by a higher substituted labor per robot and lower robot prices. On the other hand, **factory applications face longer payback** due to higher robot prices and lower substitute ratio (assuming two shifts), especially in China (6.7 years), where manufacturing wages are 23% of U.S. levels. Delivery to door faces a longer payback mainly due to low substitute ratio (assuming pairing one robot with one courier).

4) For the material handling and installation use cases, we also compare the payback of humanoid robots with "AGV + cobot" solutions. In short, while "AGV + cobot" solutions currently offer a shorter payback period (4 years and 2.6 years in China and U.S. respectively vs. 6.7 years and 2.7 years from humanoids), we expect humanoid robots to achieve better economics over time as production scales.

5) Overall, **ROI is already compelling for patrol globally and for three of the four use cases in the U.S., even at today's robot prices.** To achieve a 2.5-year payback, robot price would need to fall to $30-40k in China (17k for delivery to door) and could remain at $130-140k (46k for delivery to door) in the U.S. As scale and supply chain efficiencies drive costs down, similar to EV and batteries (Exhibit 8), where **costs decline by 15-18% when volume doubles, robot pricing should not be a major concern.**

EXHIBIT 13: **Estimated payback period: humanoid patrol in China**

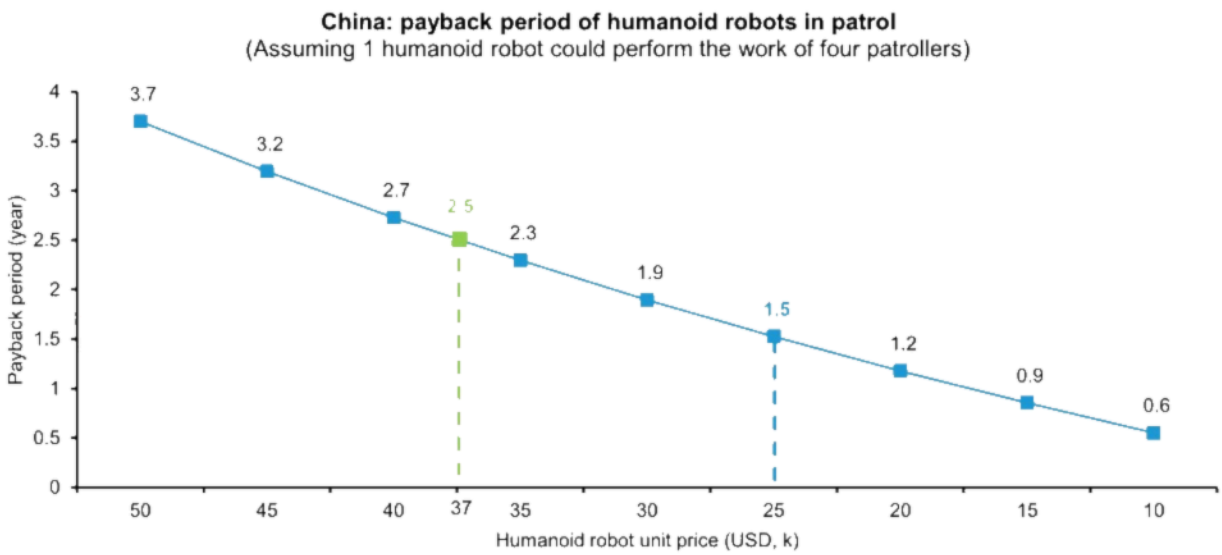
Estimated payback period of humanoid robots for patrol in China				
USD				
Upfront investment				
Upfront investment	# of humanoid robots	Robot unit price	Integration cost (% of robot price)	Sub-total
Procurement and system integration of humanoids	8	25,000	30%	**260,000**
Before replacement				
Annual labor cost	# of workers	Unit labor cost		Sub-total
Patrol staff	30	11,143		**334,286**
After replacement				
Annual robot maintenance & electricity cost	# of humanoid robots	Annual robot cost (% of robot price)	Unit cost	Sub-total
Humanoid robots	8	15%	3,750	30,000
Annual labor cost	# of operators	Unit labor cost		Sub-total
Operators	12	11,143		133,714
				163,714
Annual cost saved				**170,571**
Payback years				**1.5**

Assumptions

Unit Labor cost (USD)	
Basic annual wage	8,571
Plus: welfare+miscellaneous (% of basic annual wage)	30%
Total annual wage	11,143
Robot cost (USD)	
Robot cost	
Purchase price	25,000
Integration & setup (30% of price)	7,500
Maintenance & electricity (15% of price)	3,750
Operation mode & efficiency	
# of patrol staff substituted by 1 humanoid	4
# of humanoid robots looked after by 1 operator	5
USD/RMB	7

Apart from the operators looking after humanoids, we estimate each shift will have 2 additional operators to conduct on-site monitoring and respond to incidents.
Source: Bernstein analysis

EXHIBIT 14: **Payback sensitivity: humanoid patrol in China**



Source: Bernstein analysis

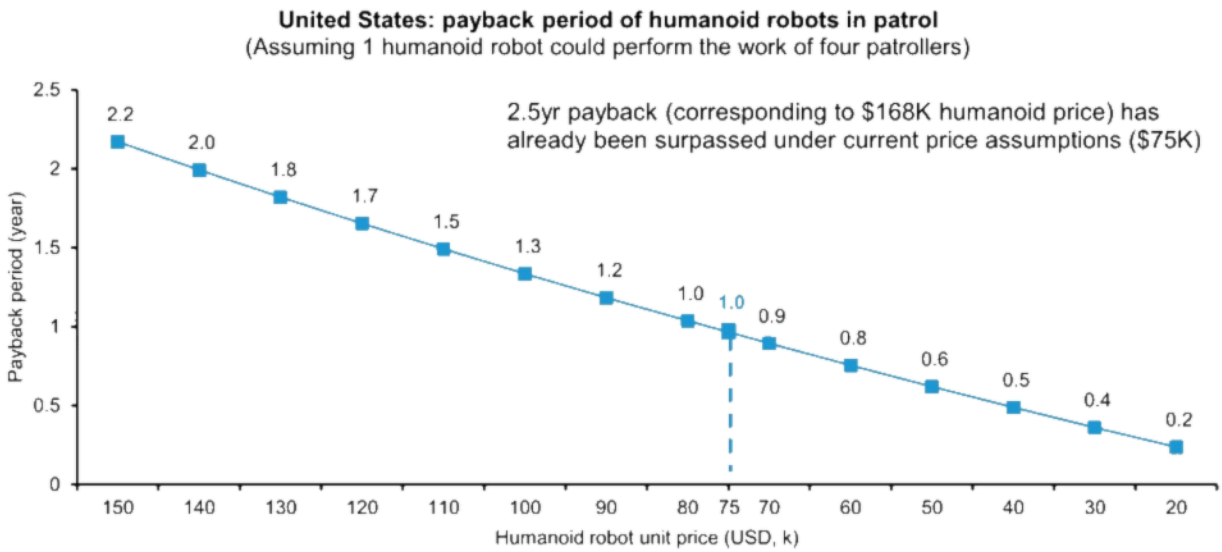
EXHIBIT 15: **Estimated payback period: humanoid patrol in the U.S.**

Estimated payback period of humanoid robots for patrol in the U.S.				
USD				
Upfront investment				
Upfront investment	# of humanoid robots	Robot unit price	Integration cost (% of robot price)	Sub-total
Procurement and system integration of humanoids	8	75,000	30%	**780,000**
Before replacement				
Annual labor cost	# of workers	Unit labor cost		Sub-total
Patrol staff	30	49,920		**1,497,600**
After replacement				
Annual robot maintenance & electricity cost	# of humanoid robots	Annual robot cost (% of robot price)	Unit cost	Sub-total
Humanoid robots	8	15%	11,250	90,000
Annual labor cost	# of operators	Unit labor cost		Sub-total
Operators	12	49,920		599,040
				689,040
Annual cost saved				**808,560**
Payback years				**1.0**

Assumptions	
Unit Labor cost (USD)	
Basic annual wage	38,400
Plus: welfare+miscellaneous (% of basic annual wage)	30%
Total annual wage	49,920
Robot cost (USD)	
Robot cost	
Purchase price	75,000
Integration & setup (30% of price)	22,500
Maintenance & electricity (15% of price)	11,250
Operation mode & efficiency	
# of patrol staff substituted by 1 humanoid	4
# of humanoid robots looked after by 1 operator	5
USD/RMB	7

Apart from the operators looking after humanoids, we estimate each shift will have 2 additional operators to conduct on-site monitoring and respond to incidents.
Source: Bernstein analysis

EXHIBIT 16: **Payback sensitivity: humanoid patrol in the U.S.**



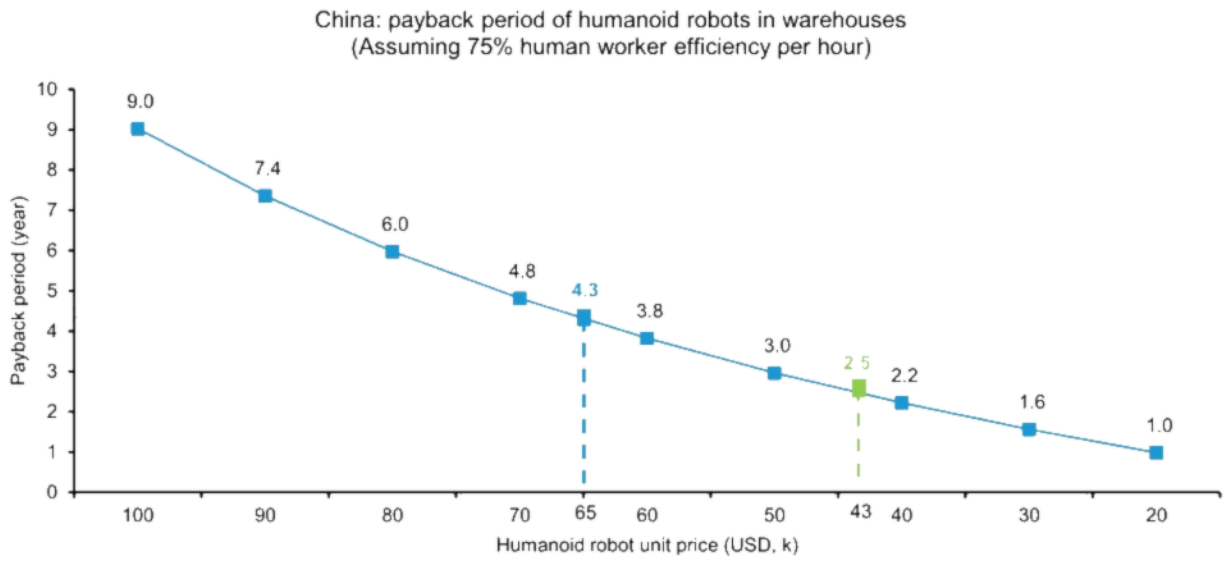
Source: Bernstein analysis

EXHIBIT 17: **Estimated payback period: humanoids in China's warehouses**

Estimated payback period of humanoid robots in China's warehouses				
Illustration of economics (every 2 humanoid robots in warehouse, all in USD)				
Upfront investment				
Upfront investment	# of humanoid robots	Robot unit price	Integration cost (% of robot price)	Sub-total
Procurement and system integration of humanoid robots	2	65,000	30%	**169,000**
Before replacement				
Annual labor cost	# of workers	Unit labor cost	Implied shifts (relative to robot)	Sub-total
Warehouse workers	1.5	19,061	3.7	**105,845**
After replacement				
Annual robot maintenance & electricity cost	# of humanoid robots	Annual robot cost (% of robot price)	Unit cost	Sub-total
Humanoid robots	2	15%	9,750	19,500
Annual labor cost	# of operators	Unit labor cost	Implied shifts (relative to robot)	Sub-total
Operators	0.7	19,061	3.7	47,042
				66,542
Annual cost saved				**39,303**
Payback years				**4.3**
Assumptions				
Unit labor cost (USD)				
Basic annual wage				14,663
Plus: welfare+miscellaneous (% of basic annual wage)				30%
Total annual wage				19,061
Robot cost (USD)				
Robot cost				
Purchase price				65,000
Integration & setup (30% of price)				19,500
Maintenance & electricity (15% of price)				9,750
Operation mode & efficiency				
Humanoid robots' working efficiency relative to human workers per hour				75%
# of humanoid robots looked after by 1 operator				3
Working time & shifts				
Working hours per day - human				8
Working hours per day - robot (with battery swap)				22
Implied shifts per day (human relative to robot)				2.8
Working days per year - human (i.e. 52 weeks*5 working days per week)				260
Working days per year - robot (assume 15 days of maintenance per year)				350
Implied shifts per year (human relative to robot)				3.7
USD/RMB				7

The payback period estimate is different from our previous version as we update our estimate on current robot unit price from $50K to $65K.
Source: Bernstein analysis

EXHIBIT 18: **Payback sensitivity: humanoids in China's warehouses**



Source: Bernstein analysis

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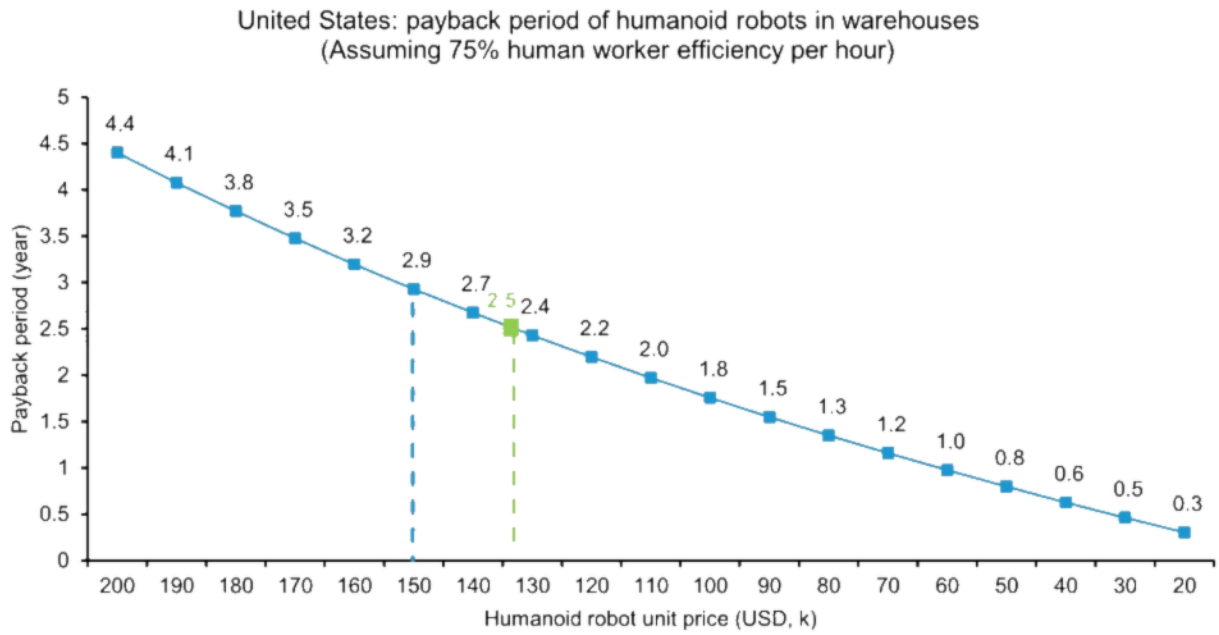
EXHIBIT 19: **Estimated payback period: humanoids in the American warehouses**

Estimated payback period of humanoid robots in the U.S. Warehouses				
Illustration of economics (every 2 humanoid robots in warehouse, all in USD)				
Upfront investment				
Upfront investment	# of humanoid robots	Robot unit price	Integration cost (% of robot price)	Sub-total
Procurement and system integration of humanoid robots	2	150,000	30%	**390,000**
Before replacement				
Annual labor cost	# of workers	Unit labor cost	Implied shifts (relative to robot)	Sub-total
Warehouse workers	1.5	57,744	3.7	**320,647**
After replacement				
Annual robot maintenance & electricity cost	# of humanoid robots	Annual robot cost (% of robot price)	Unit cost	Sub-total
Humanoid robots	2	15%	22,500	45,000
Annual labor cost	# of operators	Unit labor cost	Implied shifts (relative to robot)	Sub-total
Operators	0.7	57,744	3.7	142,510
				187,510
Annual cost saved				**133,137**
Payback years				**2.9**

Assumptions	
Unit Labor cost (USD)	
Basic annual wage	44,419
Plus: welfare+miscellaneous (% of basic annual wage)	30%
Total annual wage	57,744
Robot cost (USD)	
Robot cost	
Purchase price	150,000
Integration & setup (30% of price)	45,000
Maintenance & electricity (15% of price)	22,500
Operation mode & efficiency	
Humanoid robots' working efficiency relative to human workers	75%
# of humanoid robots looked after by 1 operator	3
Working time & shifts	
Working hours per day - human	8
Working hours per day - robot (with battery swap)	22
Implied shifts per day (human relative to robot)	2.8
Working days per year - human (i.e. 52 weeks * 5 working days per week)	260
Working days per year - robot (assume 15 days of maintenance per year)	350
Implied shifts per year (human relative to robot)	3.7
USD/RMB	7

Source: Bernstein analysis

EXHIBIT 20: **Payback sensitivity: humanoids in American warehouses**



Source: Bernstein analysis

EXHIBIT 21: **Estimated payback period: humanoids in China's delivery to door**

Estimated payback period of humanoid robots in China's parcel delivery to door
Each courier transports a humanoid robot to an area, where the courier and robot are each assigned to one building
Assuming each order generate 2 RMB (0.29 USD)

Illustration of economics in one delivery station, all in USD

Upfront investment in humanoid robot solutions

Upfront investment	# of humanoid robots	Robot unit price	Integration cost (% of robot price)	Sub-total
Procurement and system integration of humanoids	2	25,000	30%	**65,000**

Annual net revenue

# of humanoid robots	Number of orders delivered per day	Working days per year	Per order revenue	Total revenue
2	210	312	0.29	**37,440**

Annual robot cost (% of robot price)	Robot costs	No. of operators	Operator costs	Total costs
15%	7,500	1	14,486	**21,986**

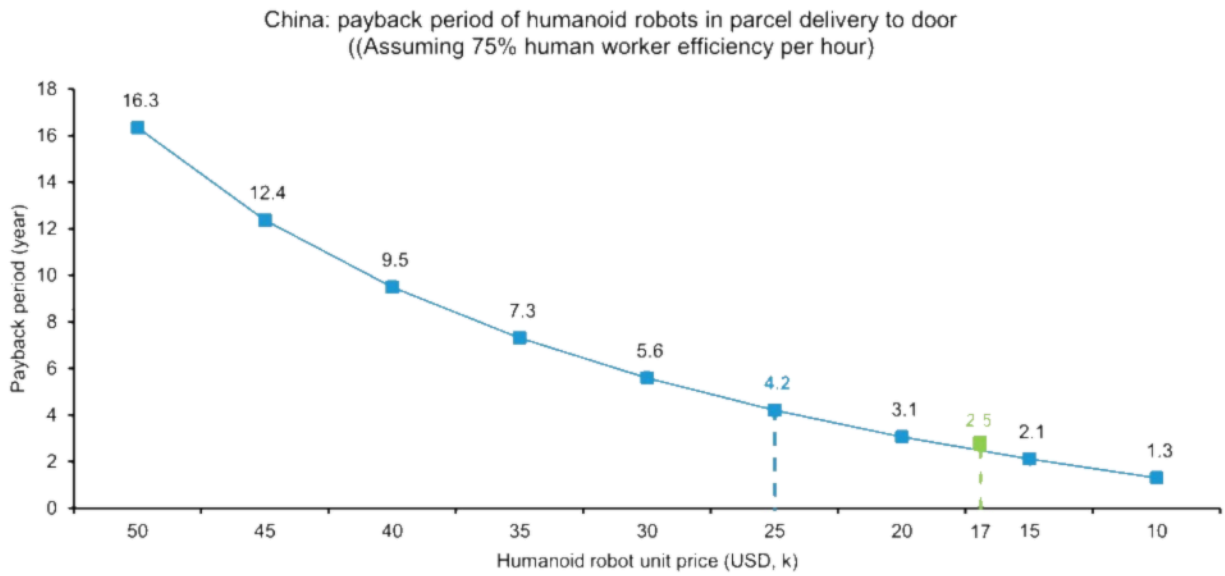
Annual net revenue (total)	**15,454**
Payback years	**4.2**

Assumptions

Unit Labor cost (USD)	
Basic annual wage	11,143
Plus: welfare+miscellaneous (% of basic annual wage)	30%
Total annual wage	14,486
Robot cost ((USD)	
Purchase price	25,000
Integration & setup (30% of price)	7,500
Maintenance & electricity (15% of price)	3,750
Operation mode & efficiency	
Humanoid robots' working efficiency relative to human workers	75%
Human average order per hour	20
Humanoid average order per hour	15
# of humanoid robots looked after by 1 operator	2
Working time & shifts	
Working hours per day - robot (with battery swap)	14
Working days per year - robot (i.e. 52 weeks*6 working days per week)	312
Per order revenue (USD)	0.29
USD/RMB	7

Source: Bernstein analysis

EXHIBIT 22: **Payback sensitivity: humanoids in China's delivery to door**



Source: Bernstein analysis

EXHIBIT 23: **Estimated payback period: humanoids in U.S. delivery to door**

Estimated payback period of humanoid robots in U.S. parcel delivery to door
Each courier transports a humanoid robot to an area, where the courier and robot are each assigned to one building.

Illustration of economics in one delivery station, all in USD

Upfront investment in humanoid robot solutions				
Upfront investment	# of humanoid robots	Robot unit price	Integration cost (% of robot price)	Sub-total
Procurement and system integration of humanoids	4	75,000	30%	**390,000**

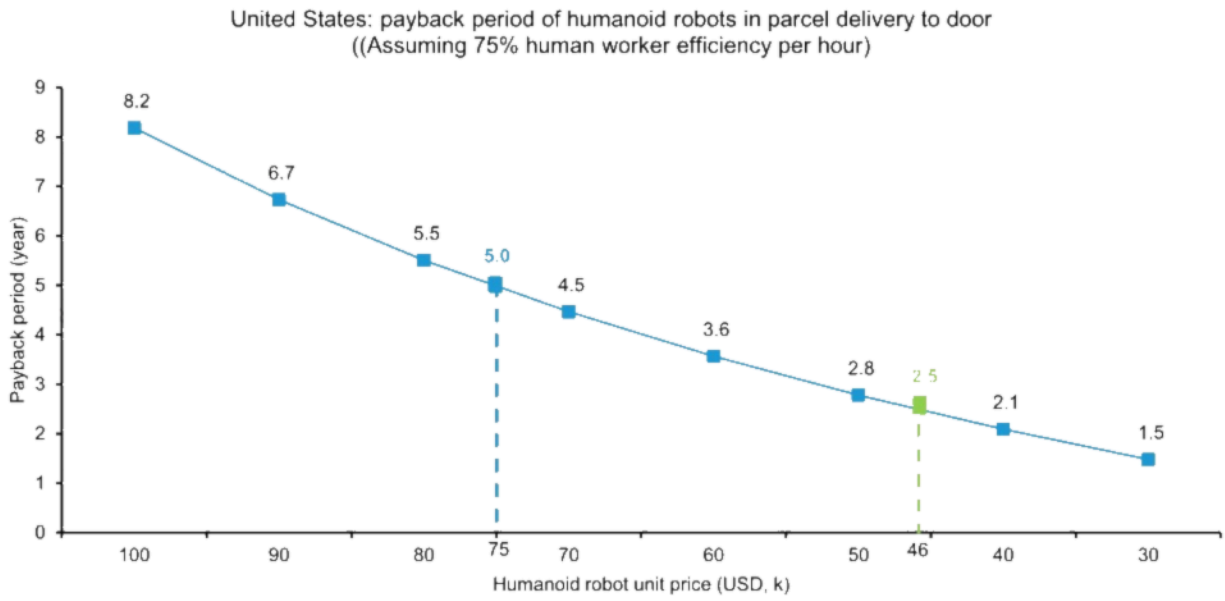
Before replacement			
Annual labor cost	# of workers	Unit labor cost	Sub-total
Couriers	10	41,184	**411,840**

After replacement (Courier + humanoid robot + robot operator)				
Annual robot maintenance, electricity, and labor cost	# of humanoid robots/workers	Annual robot cost (% of robot price)	Unit cost	Sub-total
Humanoid robots	4	15%	11,250	45,000
Couriers	5	41,184		205,920
Operators	2	41,184		82,368
				333,288
Annual cost saved				**78,552**
Payback years				**5.0**

Assumptions	
Unit Labor cost (USD)	
Basic annual wage	31,680
Plus: welfare+miscellaneous (% of basic annual wage)	30%
Total annual wage	41,184
Robot cost ((USD)	
Purchase price	75,000
Integration & setup (30% of price)	22,500
Maintenance & electricity (15% of price)	11,250
Operation mode & efficiency	
Humanoid robots' working efficiency relative to human workers	75%
# of humanoid robots looked after by 1 operator	2
Working time & shifts	
Working hours per day - human	7
Working hours per day - robot (with battery swap)	11
Working days per year - human (i.e. 52 weeks*5 working days per week)	260
Working days per year - robot (same as human)	260
Before	
Avg. daily parcel orders per courier	140
No. of couriers per station	**10**
Total orders fulfilled per year	364,000
After	
Avg. daily parcel orders per courier	140
Avg. daily parcel orders per humanoid	175
No. of couriers per station	**5**
Annual orders fulfilled by couriers	182,000
Remaining orders	182,000
No. of humanoids per station	**4**
No. of operators per station	**2**
USD/RMB	7

Source: Bernstein analysis

EXHIBIT 24: **Payback sensitivity: humanoids in U.S. delivery to door**



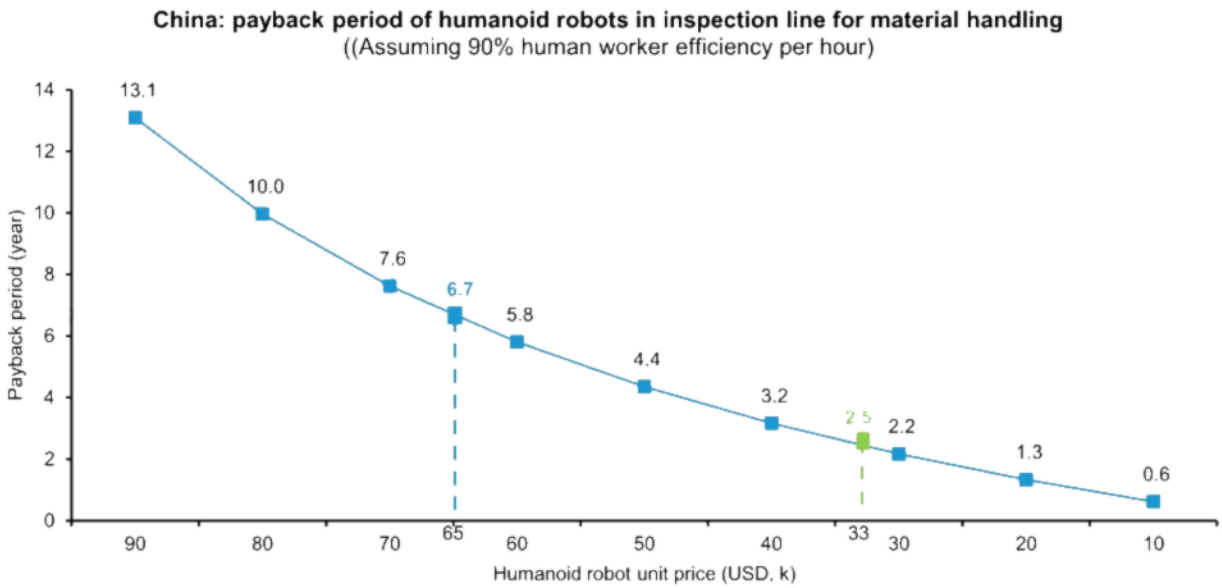
Source: Bernstein analysis

EXHIBIT 25: **Estimated payback period: humanoids in China's inspection line for material handling**

Estimated payback period of humanoid robots in China's Inspection line for material handling				
USD				
Upfront investment in humanoid robot solutions				
Upfront investment	# of humanoid robots	Robot unit price	Integration cost (% of robot price)	Sub-total
Procurement and system integration of humanoids	2	65,000	30%	**169,000**
Before replacement (only warehouse workers)				
Annual labor cost	# of workers	Unit labor cost	Implied shifts (relative to robot)	Sub-total
Factory workers	1.8	14,706	2.7	**71,269**
After replacement (humanoid robots + robot operators)				
Annual maintenance & electricity cost	# of humanoid robots	Annual robot cost (% of robot price)	Unit cost	Sub-total
Humanoid robots	2	15%	9,750	19,500
Annual labor cost	# of operators	Unit labor cost	Implied shifts (relative to robot)	Sub-total
Operators	0.7	14,706	2.7	26,396
				45,896
Annual cost saved				**25,373**
Payback years				**6.7**
Assumptions				
Unit labor cost (USD)				
Basic annual wage				11,313
Plus: welfare+miscellaneous (% of basic annual wage)				30%
Total annual wage				14,706
Robot cost (USD)				
Robot cost				
Purchase price				65,000
Integration & setup (30% of price)				19,500
Maintenance & electricity (15% of price)				9,750
Operation mode & efficiency				
Humanoid robots' working efficiency relative to human workers				90%
# of humanoid robots looked after by 1 operator				3
Working time & shifts				
Working hours per day - human				8
Working hours per day - robot (with battery swap)				16
Implied shifts per day (human relative to robot)				2.0
Working days per year - human (i.e. 52 weeks*5 working days per week)				260
Working days per year - robot (assume 15 days of maintenance per year)				350
Implied shifts per year (human relative to robot)				2.7
USD/RMB				7

Source: Bernstein analysis

EXHIBIT 26: **Payback sensitivity: humanoids in China's inspection line for material handling**



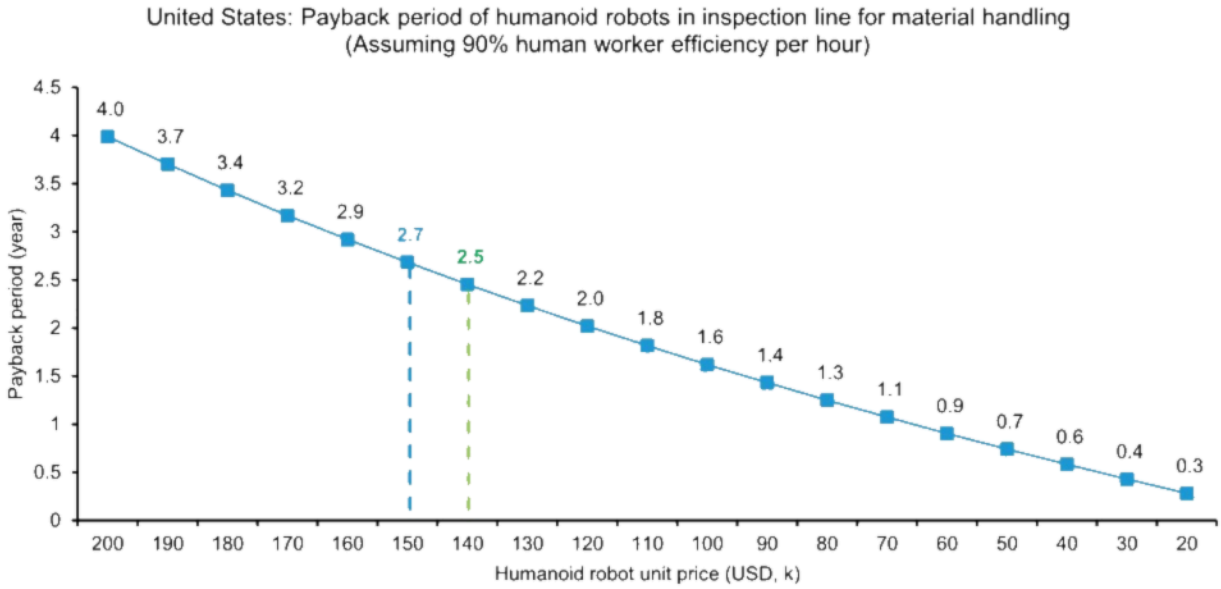
Source: Bernstein analysis

EXHIBIT 27: **Estimated payback period: humanoids in U.S. inspection line for material handling**

Estimated payback period of humanoid robots in US Inspection line for material handling				
USD				
Upfront investment in humanoid robot solutions				
Upfront investment	# of humanoid robots	Robot unit price	Integration cost (% of robot price)	Sub-total
Procurement and system integration of humanoid robots	2	150,000	30%	**390,000**
Before replacement				
Annual labor cost	# of workers	Unit labor cost	Implied shifts (relative to robot)	Sub-total
Factory workers	1.8	62,400	2.7	**302,400**
After replacement (humanoid robots + robot operators)				
Annual robot maintenance & electricity cost	# of humanoid robots	Annual robot cost (% of robot price)	Unit cost	Sub-total
Humanoid robots	2	15%	22,500	45,000
Annual labor cost	# of operators	Unit labor cost	Implied shifts (relative to robot)	Sub-total
Operators	0.7	62,400	2.7	112,000
				157,000
Annual cost saved (excl. upfront humanoid robot investment)				**145,400**
Payback years				**2.7**
Assumptions				
Unit labor cost (USD)				
Basic annual wage				48,000
Plus: welfare+miscellaneous (% of basic annual wage)				30%
Total annual wage				62,400
Robot cost (USD)				
Robot cost				
Purchase price				150,000
Integration & setup (30% of price)				45,000
Maintenance & electricity (15% of price)				22,500
Operation mode & efficiency				
Humanoid robots' working efficiency relative to human workers				90%
# of humanoid robots looked after by 1 operator				3
Working time & shifts				
Working hours per day - human				8
Working hours per day - robot (with battery swap)				16
Implied shifts per day (human relative to robot)				2.0
Working days per year - human (i.e. 52 weeks*5 working days per week)				260
Working days per year - robot (assume 15 days of maintenance per year)				350
Implied shifts per year (human relative to robot)				2.7
USD/RMB				7

Source: Bernstein analysis

EXHIBIT 28: **Payback sensitivity: humanoids in U.S. inspection line for material handling**



Source: Bernstein analysis

INVESTMENT IMPLICATIONS

We rate Hesai, Tuopu, Shuanghuan, Inovance, Harmonic Drive, JD, Xiaomi, BYD, Amazon Outperform; Sanhua, Estun, XPeng Market-Perform; Leader Drive, Coupang Underperform.

BERNSTEIN TICKER TABLE

Ticker	Rating	Cur	21 Aug 2026 Closing Price	Price Target	TTM Rel. Perf.	Cur	Reported EPS 2025A	Reported EPS 2026E	Reported EPS 2027E	Reported P/E (x) 2025A	Reported P/E (x) 2026E	Reported P/E (x) 2027E
HSAI (Hesai)	O	USD	19.10	29.00	(49.8)%	CNY	2.91	3.18	5.26	44.1	40.4	24.4
2525.HK (Hesai)	O	HKD	18.00	29.00	NA	CNY	0.36	0.40	0.66	42.4	38.8	23.5
688017.CH (Leader Drive)	U	CNY	295.15	115.00	64.9%	CNY	0.69	0.83	0.96	426.3	353.8	307.0
601689.CH (Tuopu)	O	CNY	46.30	75.00	(53.1)%	CNY	1.61	1.81	2.36	28.8	25.6	19.7
2050.HK (Sanhua)	M	HKD	26.40	27.00	(43.3)%	CNY	1.03	0.97	1.11	22.0	23.3	20.5
002050.CH (Sanhua)	M	CNY	35.71	39.00	(16.2)%	CNY	1.03	0.97	1.11	34.7	36.7	32.3
002472.CH (Shuanghuan)	O	CNY	35.23	60.00	(39.1)%	CNY	1.50	1.70	2.00	23.5	20.7	17.6
300124.CH (Inovance)	O	CNY	58.30	82.00	(48.2)%	CNY	1.87	2.19	2.65	31.2	26.6	22.0
6324.JP (HDSI)	O	JPY	5,680.00	7,800.00	90.6%	JPY	16.99	57.37	79.51	334.3	99.0	71.4
002747.CH (Estun)	M	CNY	30.82	26.00	(4.3)%	CNY	0.05	0.31	0.32	616.4	100.3	95.3
2715.HK (Estun)	M	HKD	16.80	17.26	NA	CNY	0.05	0.31	0.32	336.0	54.7	51.9
9618.HK (JD)	O	HKD	113.30	155.00	(38.6)%	HKD	10.46	14.84	16.70	10.8	7.6	6.8
JD (JD)	O	USD	29.37	40.00	(28.3)%	CNY	18.15	25.76	28.99	10.9	7.7	6.8
CPNG (Coupang)	U	USD	16.45	12.00	(63.3)%	USD	0.11	(0.54)	0.21	146.0	(30.2)	79.9
1810.HK (Xiaomi)	O	HKD	27.82	35.00	(67.5)%	CNY	1.62	0.89	1.29	14.7	26.9	18.5
XPEV (XPeng)	M	USD	12.19	20.00	(69.1)%	CNY	(1.20)	(2.03)	0.45	(68.5)	(40.3)	181.4
9868.HK (XPeng)	M	HKD	47.68	78.00	(80.0)%	CNY	(0.60)	(1.02)	0.23	(68.3)	(40.2)	181.0
1211.HK (BYD)	O	HKD	92.80	130.00	(50.7)%	CNY	3.58	4.15	5.57	22.2	19.2	14.3
002594.CH (BYD)	O	CNY	90.66	114.00	(50.0)%	CNY	3.58	4.15	5.57	25.3	21.8	16.3
AMZN (Amazon)	O	USD	258.63	320.00	(7.5)%	USD	7.17	12.65	12.13	36.1	20.4	21.3
ASIAX			1,976.42									
JPL			2,642.77									
SPX			7,674.37									

O - Outperform, M - Market-Perform, U - Underperform, NR - Not Rated, CS - Coverage Suspended

9618.HK, JD, CPNG estimate is Adjusted EPS; 9618.HK, JD, CPNG valuation is Adjusted P/E (x);

Source: Bloomberg, Bernstein estimates and analysis.