FOR INFORMATIONAL PURPOSES ONLY

BIG IDEAS 2024

年度研究报告

ARK INVEST

本报告为ARK投资出品的年度研究报告，供学习参考，请勿用于商业用途

ARK Investment Management LLC. This is not a recommendation in relation to any named particular securities/cryptocurrencies and no warranty or guarantee is provided. Any references to particular securities/cryptocurrencies are for illustrative purposes only. There is no assurance that the Adviser will make any investments with the same or similar characteristics as any investment presented. The reader should not assume that an investment identified was or will be profitable. PAST PERFORMANCE IS NOT INDICATIVE OF FUTURE PERFORMANCE, FUTURE RETURNS ARE NOT GUARANTEED.

投资创新的风险

注意：ARK所相信的公司正在利用颠覆性创新和开发技术来取代旧技术或创造新市场，但实际上可能不会如此。ARK旨在教育投资者，并寻求评估潜在的投资机会，并指出风险和不确定性可能会影响我们的预测和研究模型。所呈现的内容仅供投资者参考，并注意某些创新领域的市场风险、颠覆性创新风险、监管风险和相关风险

请仔细阅读风险披露。

→ Aim for a cross-sector understanding of technology and combine top-down and bottom-up research.

→ Aim to understand the regulatory, market, sector, and company risks. (See Disclosure Page)

Sources: ARK Investment Management LLC, 2023.

Big Ideas 2024

打破常规，定义未来

ARK投资自豪地发表“Big Ideas 2024：打破常规，定义未来。”
这是我们自2017年以来的传统。Big Ideas系列对技术融合及其对工业和经济的革命性潜力进行了全面的分析。

ARK寻求通过投资颠覆式创新的领导者、推动者和受益者实现长期资本增值。
ARK坚信创新不仅是增长的关键，也是韧性的关键，ARK强调在每个投资者的投资组合中对创新进行战略性配置的必要性。这种方法旨在利用在广泛的指数中经常被忽视的指数级增长机会，而同时对冲面临颠覆的现有企业带来的风险。

我们希望您喜欢Big Ideas 2024。

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根据ARK的研究，颠覆性技术之间的融合将定义这十年。
五大技术平台——人工智能、公有区块链、多组学测序、储能和机器人技术正在融合，并会改变全球经济活动。

技术融合创造的宏观经济转变，影响力远超第一次和第二次工业革命。
在全球范围内，实际经济增长可能从过去125年的平均3%提速至未来7年7%以上，原因是机器人振兴制造业、自动驾驶出租车改变了交通运输，而人工智能则提高了知识工作者的生产力。

在人工智能突破的催化下，到2030年，与颠覆性创新相关的全球股票市场价值占比会从16%增加到60%以上。结果是，与颠覆性创新相关的年化股权回报率可能超过40%。在接下来的七年里，其市值从今天的19万亿美元增加到大约到2030年将达到220万亿美元。

*Throughout this section, we include public blockchain value as part of all calculations and forecasts of “equity market value.” Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

五大创新平台正在融合并定义这个技术时代

公有区块链

一旦大规模采用，所有资金和合同都可能迁移到支持和验证数字的稀缺性和所有权证明的公有区块链上。金融生态系统可能会重新配置以适应加密货币和智能合约的上升趋势。这些技术增加透明度，减少资本的影响和监管控制，并降低合同执行成本。在在这样一个世界里，数字钱包的必要性增加，更多的资产具备金钱属性，企业和消费者也会适应新的金融基础设施。公司结构本身也可能会受到质疑。

人工智能

随着数据而发展的计算系统和软件可以解决棘手的问题，自动化的知识工作，和加速技术融入每一个经济领域。神经网络的采用应该比互联网的引入更重要，并有可能创造数十万亿美元的价值。这些系统将大规模地需要前所未有的计算资源，而特定于人工智能的计算硬件应该在下一代云数据中心中占据主导地位，以训练和操作人工智能模型。终端用户的潜力是很明显的：一系列人工智能驱动的智能设备遍及人们的生活，改变他们消费、工作和娱乐的方式。人工智能的采用会改变每个行业，影响每一个业务，并催化每一个创新平台形式。

多组学测序

收集、排序和理解数字生物数据的成本正在急剧下降。多组学技术为科学家研究，治疗组织和健康组织提供了前所未有的DNA、RNA、蛋白质和数字健康数据的访问能力的平台。癌症治疗应该通过泛癌症的血液检测来改变。多组学数据应输入到新的Precis离子中使用新兴基因编辑技术靶向和治愈罕见病和慢性病的疗法条件。环境多组学应该会解锁全新的可编程生物学功能，包括新型生物材料的设计与合成，构建具有跨行业的应用，特别是农业和食品生产。

储能

先进电池技术成本 的下降应该会导致外形尺寸的爆炸式增长，让人和物品从一个地方到另一个地方的成本暴跌，自主移动得以实现。电动传动系统成本的下降会解锁微出行和空中系统，包括飞行出租车，实现改变城市景观的商业模式。自动驾驶会大幅降低出租车、送货和监控数量级，实现无摩擦交通工具可以提高电子商务的速度，并使个人拥有汽车成为例外，而不是惯例。这些创新与大型固定式电池相结合会引起能源的转变，用电力代替液体燃料，并将发电基础设施推向网络的边缘。

机器人技术

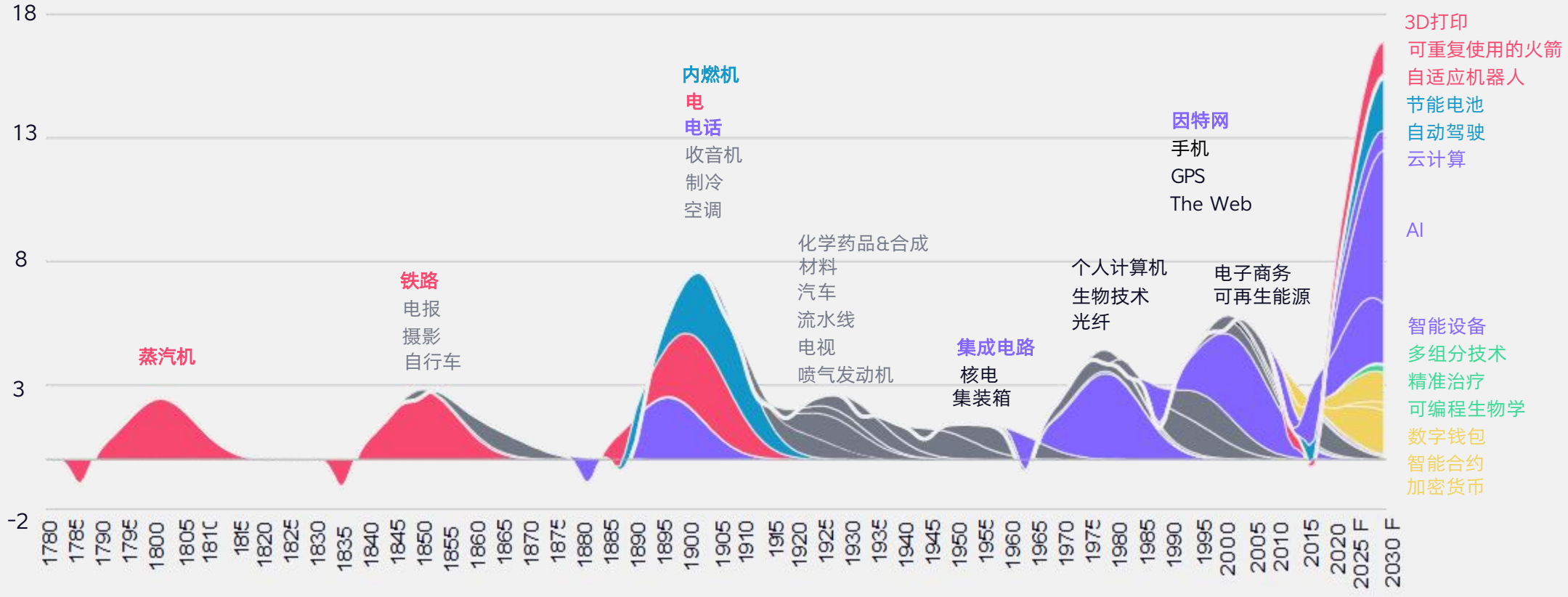
在人工智能的催化下，适应性机器人可以与人类一起操作，并驾驭遗留基础设施，改变产品的制造和销售方式。3D打印有助于制造的数字化，不仅提高了最终使用零件的性能和精度，而且提高了供应链的弹性。与此同时，世界上速度最快的机器人，可重复使用的火箭，将继续降低系列卫星的发射成本和实现无间断连接。新生的创新平台上，机器人可能会降低高超音速旅行的距离成本，3D打印机的制造复杂性成本，以及人工智能引导机器人的生产成本。

Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

融合技术正在掀起历史性的技术浪潮

通用性技术的经济影响估算

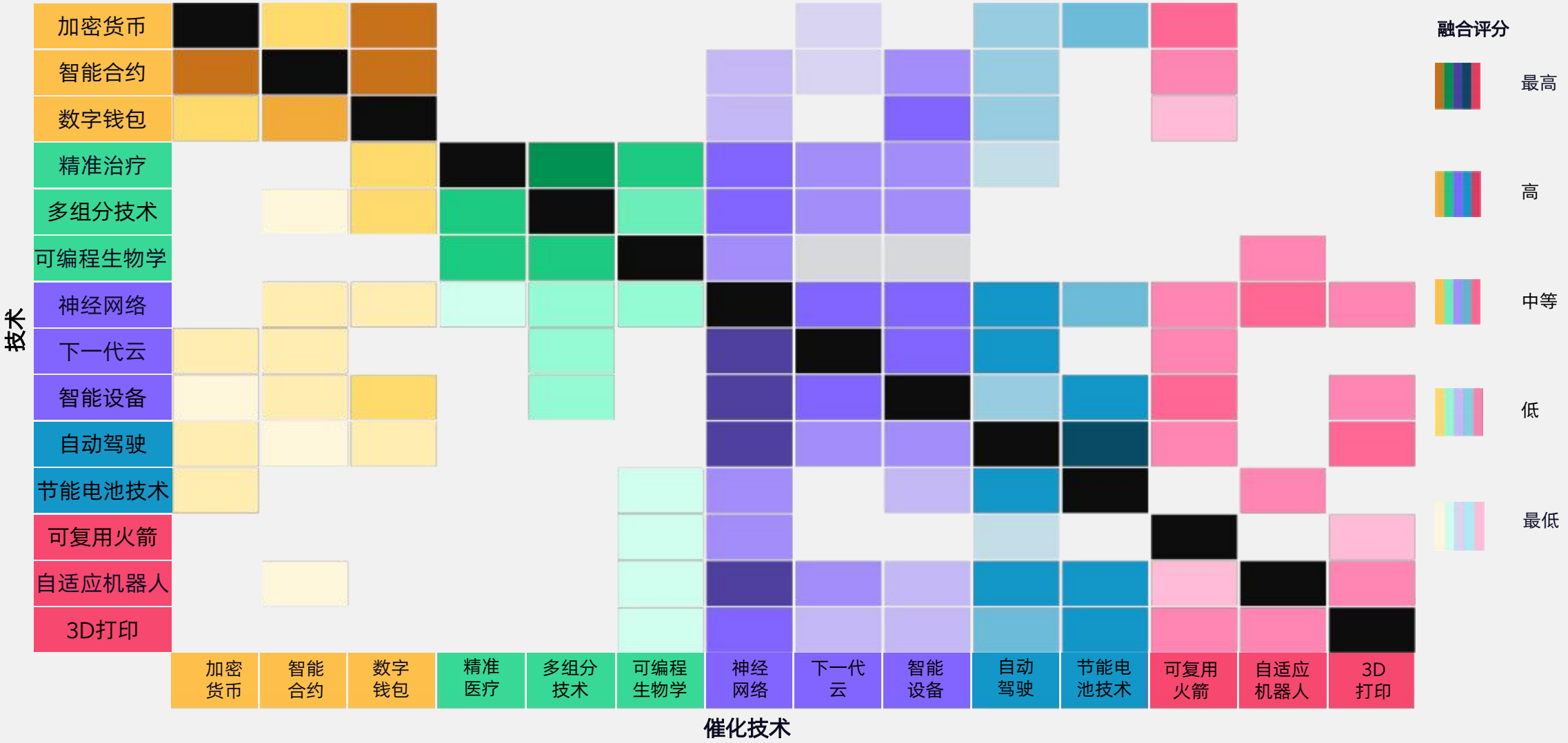
(实际GDP增长和消费者盈余的年度增加百分比)



Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying sources, including Bekar et al. 2017, which may be provided upon request. The chart uses GPT 4 prompting to survey a comprehensive list of general purpose technologies using the identification framework detailed therein. Where available, academic literature is also used to assess attributable economic impact. A GPT-4 scoring rubric assesses technology-by-technology impacts. The impact measured directly is matched against the scoring to tune all scores to produce technology-by-technology estimates of economic impact (even when direct measures of economic impact are unattainable). Consistent with General Purpose Technology theory, these technologies are assumed to go through a period of investment in which economic impact is negative before productivity advances begin to realize into economic data. All technologies are assumed to have the same diffusion and realization cycle. If recent technologies are assumed to diffuse more quickly, the current wave would appear steeper. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

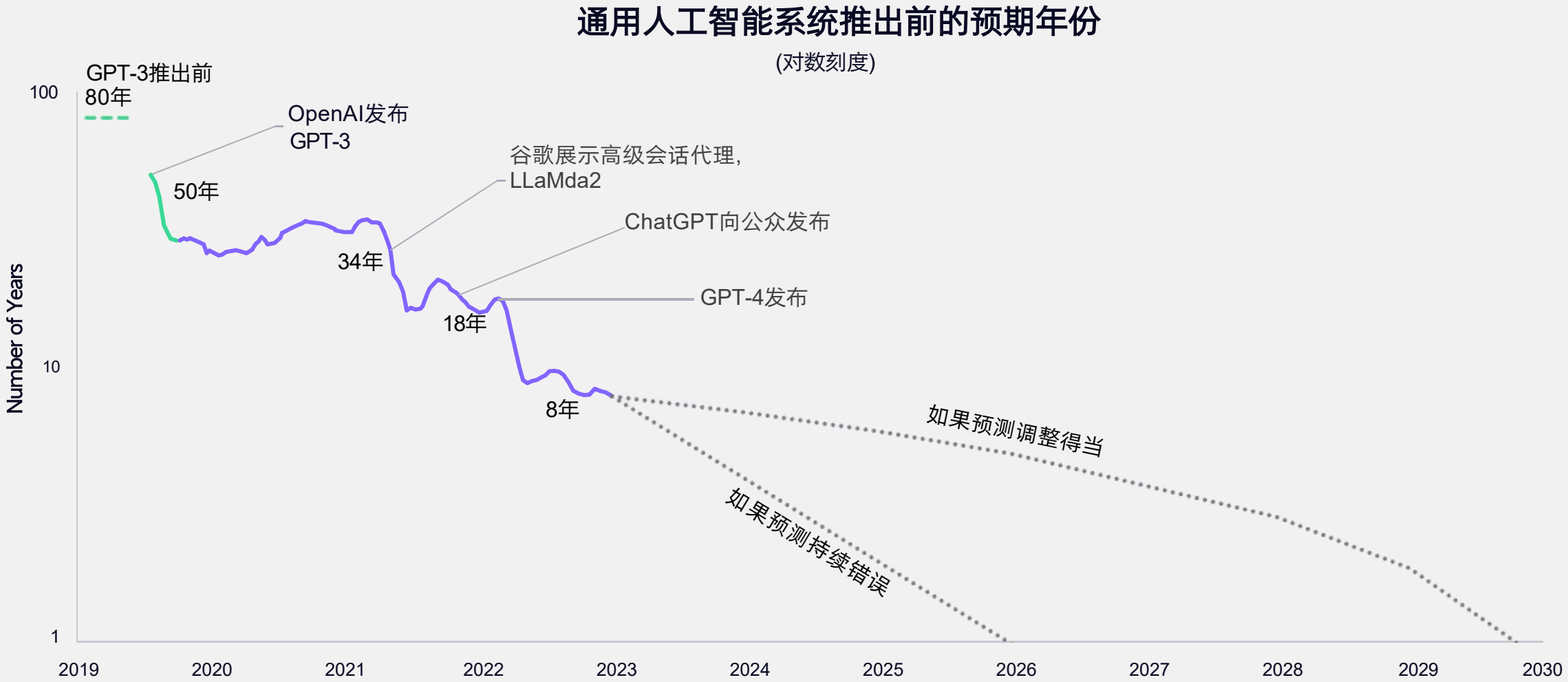
人工智能是核心技术催化剂

技术融合矩阵展现了技术之间的关系。



More detailed version of this graphic, including detailed scoring information and justification available here. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

人工智能的发展速度比预期得更快



Sources: ARK Investment Management LLC, 2024, based on data from Metaculus, including benchmark details, as of January 3, 2024. Benchmark broadly requires the successful passage of an adversarial two-hour Tuning test, broad success on a Q&A knowledge and logic benchmark, and the successful interpretation of and execution complex model car assembly instruction, all within a single system. Green lines are derived estimates for time to general purpose AI (strongly formulated) based upon forecasts for a weaker benchmark. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

单项技术进步能够合并串联成巨大的新市场机会

神经网络

先进的人工智能使自动驾驶出租车能够依赖更少、更便宜的传感器。

+

节能电池技术

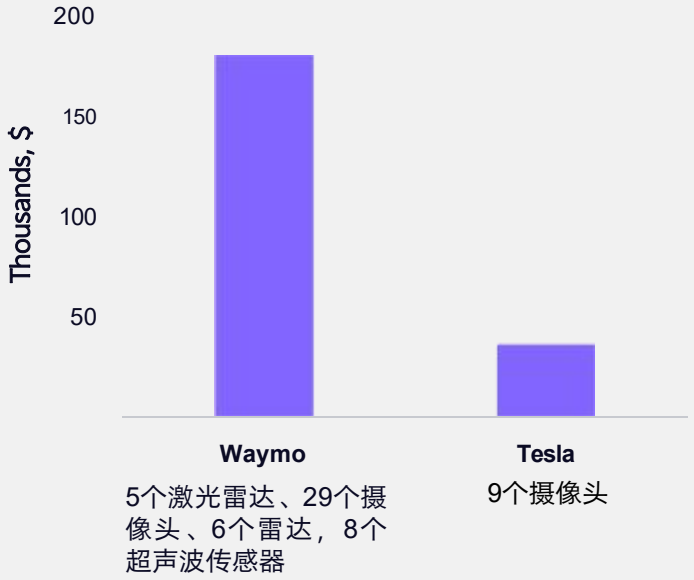
电池电动传动系统可将机器人出租车的运营成本降低 60%。

=

自动驾驶

AI和电池电动传动系统的结合使机器人出租车系统能够规模化。

机器人出租车制造成本 (每车, 2024)*



按传动系统类型，机器人出租车的每英里运营成本

自适应机器人

除了更好的电池和人工智能，通用机器人还需要更好的:

- 电动机
- 电力电子元件
- 传感器
- 高效能计算

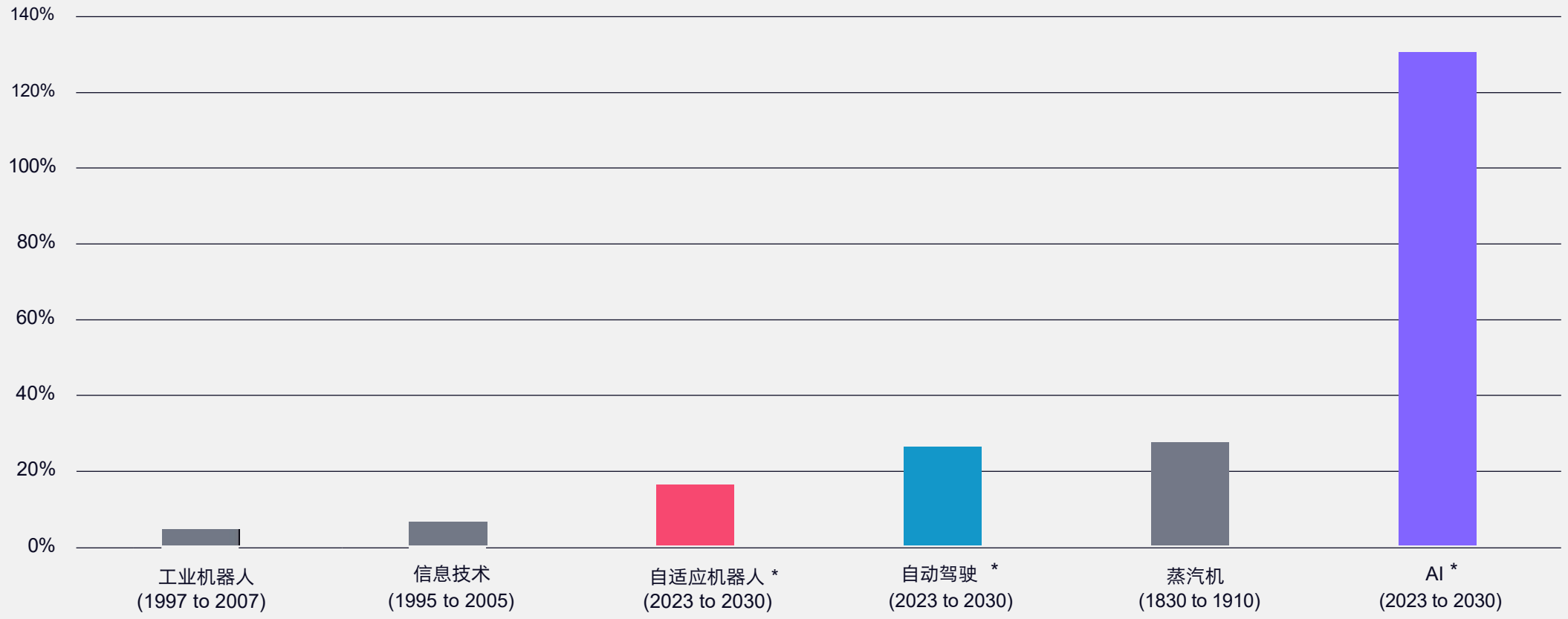
每个技术的成本会按照其学习曲线而下降。

*Waymo manufacturing costs are estimated based upon public statements. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

这些技术对经济的影响会被证明是戏剧性的

部分主要技术的经济影响

(引进技术后实际国内生产总值的累积增长)

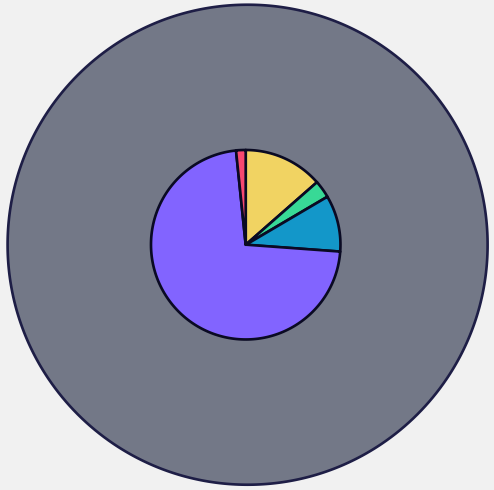


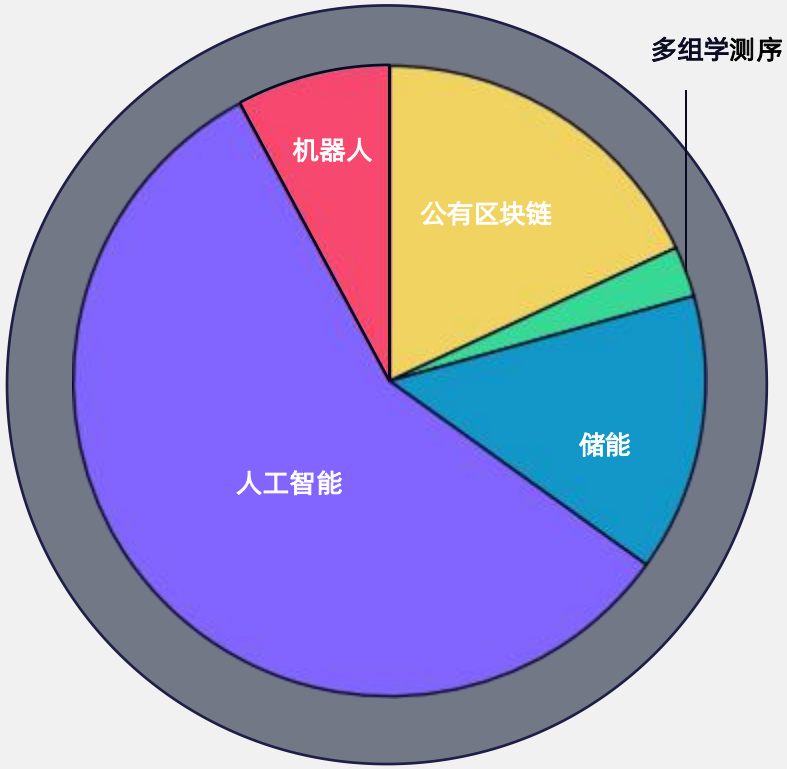
*Adaptive Robotics, Autonomous Mobility, and AI Impact are ARK Invest estimates. AI estimate includes consumer surpluses that may not be captured in traditional economic statistics. IT productivity impact likely also undercounts consumer surplus. Industrial Robot and IT impact measures impact on US, Europe, and Japanese economies. Steam Engine impact is measured against the UK economy. Sources: ARK Investment Management LLC, 2024, based on data from Crafts 2004, O' Mahony et al. 2009, and McKinsey Global Institute 2017. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Big Ideas 2024—智能小巨人科技编译版

技术创新可能具备颠覆性，足以主导全球股票市值

	2023 股票市值估算	2030 股票市值预测	年增长率 预测
非创新	$98 万亿	$140 万亿	3%
颠覆性创新	$19 万亿	$220 万亿	42%
合计	$117 万亿	$360 万亿	17%





人工智能
37%
储能
50%
公有区块链
48%
机器人
78%
多组学测序
39%

Note: Forecasted numbers are rounded. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of external sources, including the World Federation of Exchanges and the MSCI ACWI IMI Innovation Index which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Big Ideas 2024—智能小巨人科技编译版

对公有区块链的预期

尽管下表中描述的场景是用现在时写的，但它们是基于ARK的观点预测的可能结果。由于一些不确定性，这些可能的结果在未来可能无法实现。所提供的信息不应被视为投资建议，以及不应构成任何投资决策的基础。

技术	2040年的可能性	ARK的2030年进展预期
加密货币	加密货币已经取代了大多数基于权限的集中式受控的货币体系，使金融生态系统能够围绕数字资产重新制定，从而消除交易对手风险，同时继续促进交易流。这种重新制定始于传统金融体系的边缘，即货币体系破碎的地理图，以及传统金融中介机构无法提供的市场。在发达市场，加密货币最初作为一种价值储存手段，提供很少的直接效用。随着时间的流逝，真正中立的数字货币（主要是比特币）的效率已经超过了其他金融货币架构。	全球货币供应量与GDP同步增长，加密货币现在占总量的10%左右。尽管新兴市场也有这种情况，但应计的价值几乎没有归因于资金的直接转移。大部分升值是机构和高净值个人以及公司和国家国债的低个位数百分比分配的函数。加密货币继续取代黄金作为安全资产，占据40%的市场份额。汇款和全球结算等公用事业用例分别占交易量的约10%和约5%
智能合约	大多数合同已经迁移到开源协议，这些协议支持并验证数字稀缺性和所有权证明。风险分担安排更加透明，各种资产的证券化、买卖更加容易，交易对手风险大幅降低。即使更多的人类活动变得商业化，传统金融中介的重要性也在下降。由资产负债表轻的数字钱包平台支持的去中心化协议促进了大多数传统的金融功能。消费者互联网服务依赖于数字资产所有权所支持的商业模式。每个公司实体和每个消费者本身都被改编为集中式公司结构，这受到了质疑。	全球金融资产占GDP的比例持续增长，智能合约平台的担保比例不到5%，这与拨号互联网的采用曲线一致。1% 的总收入来自去中心化协议的代币化资产，不到传统金融机构收取的费用的三分之一。应用协议支付更大份额的费用来激励网络参与者，占去中心化协议总收入的75%。应用层协议和1级协议之间的混合净速率约为60bps。
数字钱包	数字钱包使几乎每个拥有连接设备的人都能即时传输和接收资金，从根本上改变了商业和金融体验的流程。促进个人用户金融服务批发定价的数字钱包已经破坏了零售银行关系，从根本上改变了消费者与金融服务提供商的关系。除了财务功能外，数字钱包是各种数字服务的分发平台-从叫车到电子商务-并且是数字健康和其他敏感数据的安全存储库。传统的金融服务机构及其相关的支付处理价值链在很大程度上已经让位于大多数经济活动的互联网数字钱包。	大约90%的智能手机用户在某种程度上依赖数字钱包。大多数人使用数字钱包作为超过一半有意义的金融功能的前端。数字钱包平台提供商继续依靠传统的生态系统来促进贷款等金融活动，但可以提取5-20%的潜在客户费用，用于向这些机构交付客户。他们还可以为通过其平台指导的电子商务活动收取3-10%的商务便利费。

Sources: ARK Investment Management LLC, 2024. In the above table, we characterize the convergent technological capabilities that we believe may manifest by 2030 and 2050. We stress that these scenarios, written in the present tense, are *possible outcomes*—not assured outcomes—and that the future may play out differently. This ARK analysis is based on a range of external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security.

对多组学测序的预期

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技术	2040年的可能性	ARK的2030年进展预期
精准治疗	技术能够操纵分子生物学系统，催化新一代更有效和持久的精确疗法。基于CRISPR的基因编辑使得能够以增加的特异性直接操作DNA。RNA作用治疗技术限制了可以转录成蛋白质的DNA区域。人工智能的进步使靶向导致潜在疾病的特定蛋白质成为可能。这些突破缩短了开发时间表，并提高了价格高于传统疗法的治疗疗法的疗效。研究人员的目标是治愈大多数罕见疾病。传统的医疗服务支出下降，将经济领域割让给了分子疗法。	精准疗法占新发布药物的25%。通过改善生活质量，降低辅助医疗成本，并经常有效地治愈疾病，他们的平均价格溢价是传统药物的7倍。加上研发效率的预期提高，这些药物在2030年为药品收入增加了15%或约3000亿美元。
多组学技术	在测序成本急剧下降的催化下，研究人员和临床医生定期收集患者的表观基因组，转录组和蛋白质组数据。随着智能设备和新兴人工智能工具日益全面的数字健康读数，他们将这些多元数据整合在一起，以了解、预测和治疗疾病。因此，癌症护理已经完全改变: 多组学技术在早期阶段检测癌症，更精确地靶向治疗，并提供复发监测。定期进行基于血液的泛癌检查是中年患者的护理标准。多组学技术提高了生物技术研发效率，因为临床试验针对患者人群并更准确，更轻松地测量结果。与人工智能相结合，多项技术改变了患者与卫生系统之间的关系。数字医疗提供商，诊断工具公司和分子检测公司正在引领这一领域。传统的药品特许经营和卫生服务系统已经失去了其突出地位。浪费的医疗保健支出随着健康生活的延长而下降。	在完全渗透的情况下，与药物开发相关的研发效率可能会翻倍，这要归功于人工智能增强的多体技术。到2030年，几乎所有新药开发计划都将多组学纳入临床前研发，约50%将AI纳入临床计划。实现的研发回报提高了10%，到2035年，研发回报几乎翻了一番。早期发现多癌症血液检查已成为护理标准，因为它们已将某些年龄组的癌症死亡率降低了25%。在发达市场，30%的患者受益于新的诊断体系。
可编程生物	人工智能工具、改进的基因组合成技术和可扩展的生物制造技术能够实现具有可预测性能的新型低成本生物构建体，推动农业和材料科学的复兴。可编程生物学使材料科学和生物基燃料取得突破，从而增加粮食产量并减少环境外部性。分子生物学基元为新的稳健计算架构提供了基础。	基因合成仍然仅限于早期阶段和开发项目，年收入为100亿美元。可编程生物学平台占据了精准治疗收入的10%。这些平台又产生了300亿美元的收入，毛利率约为70%，EBITDA利润率在35% 范围内，自由现金流利润率约为20%。

Sources: ARK Investment Management LLC, 2024. In the above table, we characterize the convergent technological capabilities that we believe may manifest by 2030 and 2050. We stress that these scenarios, written in the present tense, are *possible outcomes*—not assured outcomes—and that the future may play out differently. This ARK analysis is based on a range of external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security.

对储能的预期

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技术	2040年的可能性	ARK的2030年进展预期
自动驾驶	机器人将人和包裹从一个地方移动到另一地方，并完全改变了物理运动的经济学。出租车、送货和监测的成本下降了一个数量级乘坐机器人出租车出行是常态，拥有私人车辆是例外。无摩擦的无人机和机器人交付催化了电子商务的速度。自主移动系统生成的数据提供了对世界状况的普遍、实时的洞察。利用自主移动平台的消费者和企业正在受益，而汽车、物流、零售和保险行业的现有企业已经被颠覆。	自动驾驶的机器人出租车已经改变了全球运输，几乎每个国家都有点对点运输，平均价格约为每英里0.5美元。鉴于令人信服的价格点和实用性，机器人出租车已经行驶了13万亿英里，并且越来越受欢迎。自动驾驶出租车平台收取50%以上的平台费用或收取费率，产生约50% 的运营利润率，并为资产所有者-运营商提供产生合理资本回报率的机会。促进这种旅行的自动驾驶汽车数量约为1亿辆，大部分增量汽车生产都是自动驾驶的。
节能电池系统	电池成本的下降引发了移动形式的寒武纪般的爆炸，将电力供应推向了网络上的终端节点。随着内燃机的死亡，电动汽车在运输中占主导地位。包括飞行出租车在内的微型移动和空中系统可以实现改变城市景观的创新商业模式。所有这些创新都以牺牲液体燃料为代价推动了对电能的基本需求。它们还可以更有效地提供电能，从而降低电网的脆弱性，运营费用以及输电和配电的资本强度。石油需求正在下降，传统的汽车制造商和供应商已被少数垂直整合的技术提供商所取代。	随着乘车转向电动自动平台，每年销售的自动驾驶电动汽车数量约为7400万辆，占汽车市场的大部分。在平均售价约为2万美元的情况下，电动汽车制造商的年收入为1.4万亿美元，毛利率约为20%，息税前利润率约为10%。随着制造整合，利润增加。电池占电动汽车价值的20%左右。与电动汽车非常相似，电池制造是资本密集型和低利润率的。为电动汽车OEM提供服务，电池制造商每年产生3000亿美元的收入。固定储能需要的电池数量大致相当于电动汽车消耗的电池数量，另外产生3000亿美元的收入。

Sources: ARK Investment Management LLC, 2024. In the above table, we characterize the convergent technological capabilities that we believe may manifest by 2030 and 2050. We stress that these scenarios, written in the present tense, are *possible outcomes*—not assured outcomes—and that the future may play out differently. This ARK analysis is based on a range of external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security.

对人工智能的预期

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技术	2040年的可能性	ARK的2030年进展预期
神经网络	在大量数据的支持下，计算系统和软件正在解决以前无法解决的问题，使知识工作自动化，并加速将技术集成到所有经济过程中随着成本的下降，定制软件正在随着每一次人工智能模型的增强和连接世界而改进。学习系统非常快，其影响与微处理器的引入一样重大，改变了每个部门和地区。	人工智能模型的训练成本下降了40,000倍以上，再加上对人工智能硬件的积极投资，自2023年以来，人工智能的总体能力已经提升了大约60万倍。50%的知识型员工采用了人工智能软件系统，他们的生产率平均提高了9倍。与其他软件产品一致，企业支付10%的生产力增长来访问软件。
下一代云	云工具训练主导软件堆栈的AI模型是将人工智能运行的世界拼接在一起的软件连接。促进神经网络训练的基础设施即服务提供商芯片制造商和工具制造商已经经历了数十年的需求周期。软件开发已经民主化，提供将可互操作软件层缝合在一起的API hooks的公司经历了前所未有的需求。	1.3万亿美元的人工智能硬件支出支持13万亿美元的人工智能软件销售，并适应75%的传统软件毛利率。三种类型的客户支持对人工智能硬件的需求-基础设施即服务提供商，软件公司和人工智能基础模型提供商-它们应该产生20%的现金流利润率；与芯片制造商一致
智能设备	AI为家庭和移动中的一类新型智能设备提供动力。固定的互联网和人工智能驱动的基础设施存在于家庭和其他社会环境中，改变了所有媒体提供商的分发方式。最终用户以全新的方式与世界互动，他们的消费偏好数据催生了新的商业模式和服务。商业和投注渗透到娱乐体验中，实现和催化新的广告格式和内容货币化。节目就是商店。线性电视已经过时，因为数字策展和直接的消费者偏好驱动了视觉内容。线性内容正在让给互动体验，有时是微妙的。基于AI媒介的眼镜和耳机贯穿于日常生活之中。	消费者在智能设备硬件上的支出继续保持上升趋势，每年每位互联网用户约60美元。联网所花费的时间急剧增长到醒着的休闲时间的一半，即全球20万亿。数字体验继续以低于面对面体验的价格货币化，数字体验继续以低于面对面体验的价格获利，每小时产生0.25美元在线支出给平台提供商。在设备支出和数字娱乐体验之间，5.4万亿美元的收入归于智能设备、娱乐和社交平台。广告和商业占收入的80%。

Sources: ARK Investment Management LLC, 2024. In the above table, we characterize the convergent technological capabilities that we believe may manifest by 2030 and 2050. We stress that these scenarios, written in the present tense, are *possible outcomes*—not assured outcomes—and that the future may play out differently. This ARK analysis is based on a range of external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security.

对机器人的预期

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技术	2040年的可能性	ARK的2030年进展预期
可复用火箭	可重复使用的火箭价格低廉，并催生了新的商业模式。低地球轨道星座将地球上的每个智能手机用户连接到一个抗审查的数据馈送。高超音速点对点旅行正在成为现实，扰乱了长途飞行，改变了军事资产交付，并缩小了全球供应链。行星外的人类探索已经开始。	在SpaceX的星际飞船发射量的带动下，一个4万颗强大的卫星网络正在轨道上运行，为几乎所有智能手机提供直接到卫星的通信，并为船舶、房车、飞机，以及发达国家和发展中国家的农村居民。鉴于客户可以相对容易地上车——电源插座、天线和通往天空的清晰路径——大多数客户都参与了一个每年总计1300亿美元的潜在市场。
自适应机器人	由人工智能驱动的自适应机器人正在改变经济。在许多应用中，与现有基础设施向后兼容的类人机器人的成本已降至低于人类制造劳动力的成本。以前棘手的家庭任务正在以创造引人注目的终端市场的价格点提交给自动化。随着每次AI软件升级，机器人车队的性能都会提高。车队数据生成和AI模型训练的良性循环推动业绩向前发展。随着更广泛的实物产品受到技术驱动的成本下降的影响，制造业生产率的增长加速。机器人也继续渗透到服务业。经济进入了一个不可否认的前所未有的爆炸性增长时期。	自适应机器人已经渗透到制造过程中，足以将生产率提高15%，类人机器人的年单位销售额已增长到制造业劳动力人数的10%。更便宜的人类机器人已经开始进入家庭，特别是在发达国家。虽然能力仍然有限，但这些机器人解决了三分之一的家务劳动，它们的标价是由家庭成员节省的时间来证明的。得益于软件，机器人制造商在资本设备供应商的高端享有利润。
3D打印	3D打印消除了设计障碍，降低了成本、重量和生产时间，极大地改变了传统的制造方法。使用3D打印创建的医疗保健工具是个性化和定制的，为患者和医生带来更好的体验。更轻的3D打印航空零件减少了全球排放，并为地球和外层空间的新飞机提供了飞行。各行各业的替换零件都是按需印刷的，成本只是以前的一小部分，最终导致供应链短缺。3D打印使人工智能能够设计曾经无法制造的零件。	3D打印继续主导原型市场，并已渗透到中间模具市场的大部分领域，从而实现了注塑和金属铸造应用的低成本设计迭代。对行业增长最重要的是，3D打印已经开始在航空航天和汽车领域的最终应用中得到有意义的应用，这些市场每年的设备总销量超过4万亿美元。在所有行业中，近9000亿美元的最终用途零件可以采用3D打印，尽管这种渗透率仍处于青少年阶段。

Sources: ARK Investment Management LLC, 2024. In the above table, we characterize the convergent technological capabilities that we believe may manifest by 2030 and 2050. We stress that these scenarios, written in the present tense, are *possible outcomes*—not assured outcomes—and that the future may play out differently. This ARK analysis is based on a range of external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security.

Big Ideas 2024—智能小巨人科技编译版

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人工智能

扩展全球智能并重新定义工作

本报告为ARK投资出品的年度研究报告，智能小巨人科技进行了编译，仅供学习参考，请勿用于商业用途

Sources: ARK Investment Management LLC, 2024. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

凭借在各种测试中的超人表现，像GPT-4这样的人工智能模型会催化前所未有的生产力繁荣。受到ChatGPT的 “iPhone” 般的时刻的影响，企业正争先恐后地利用人工智能 (AI) 的潜力。

归功于成本的迅速下降和开源模型，人工智能带来的不仅仅是效率的提高。如果知识工人的生产率到2030年翻两番，正如我们所认为的那样，实际GDP的增长可能会加速，并在未来五到十年内打破纪录。

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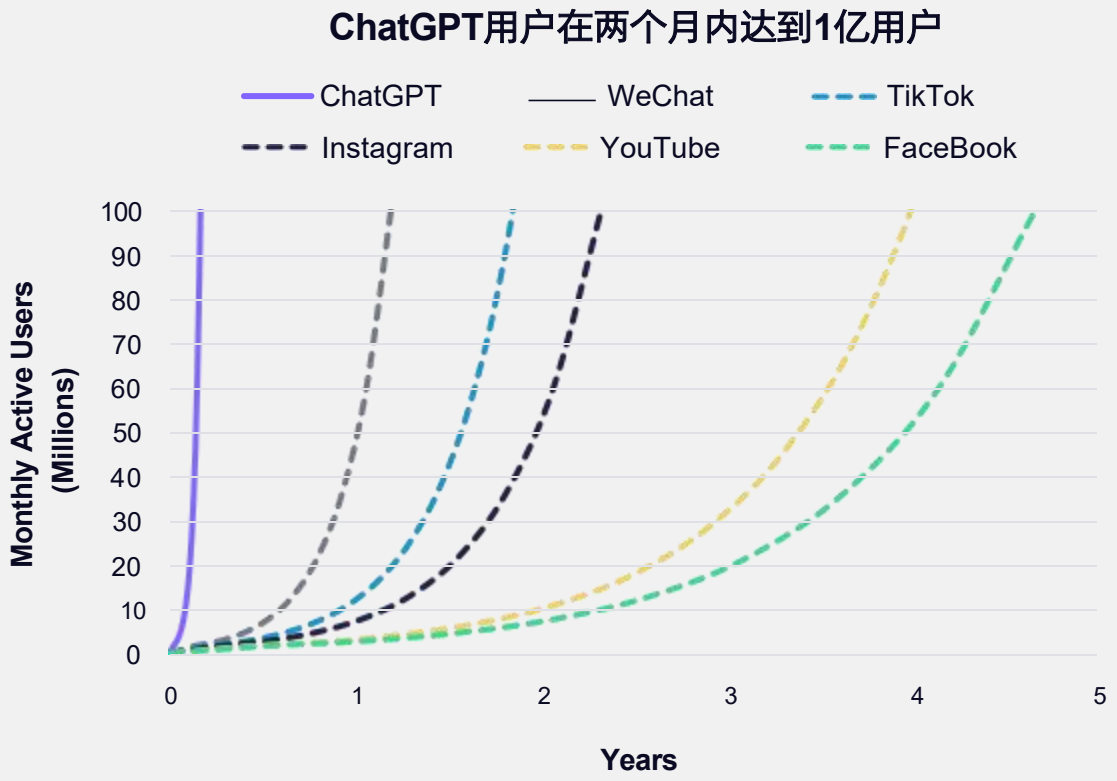
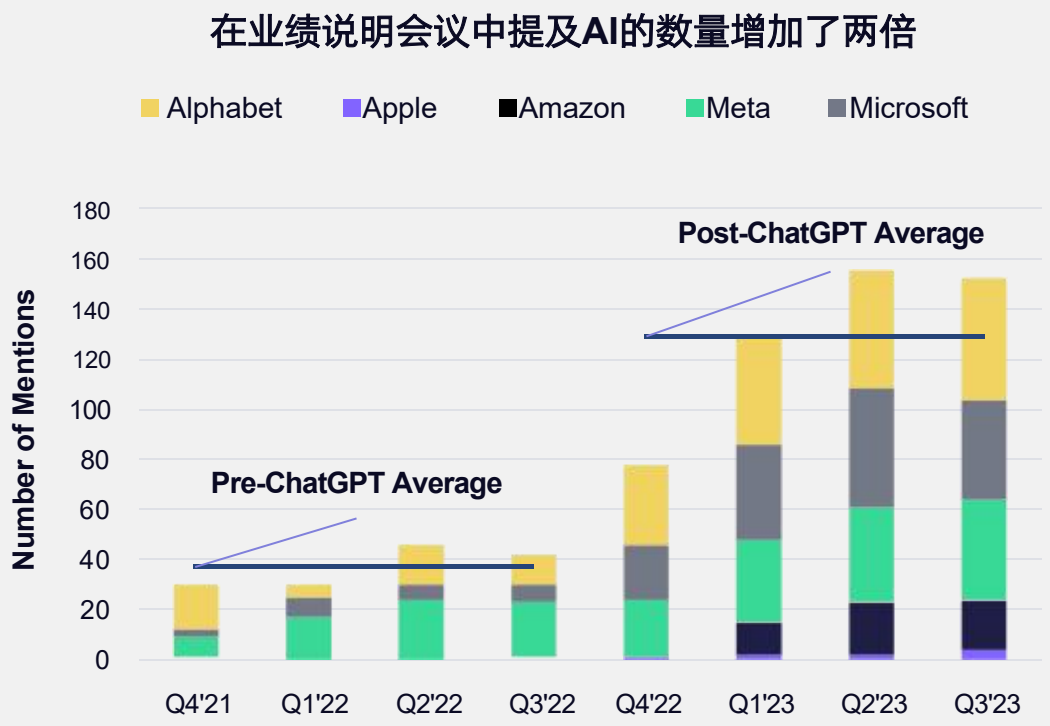
ChatGPT让消费者感到高兴，让企业感到惊讶

自2017年Google发明transformer架构以来，ChatGPT在多年的进步基础上，促进了公众对生成AI的理解。ChatGPT不再只是开发人员的工具，它简单的聊天界面使任何说任何语言的人都能利用大型语言模型(LLM) 的强大功能。2023年，企业争先恐后地了解和部署生成式AI。



*values between 0 and 100 million users are estimates

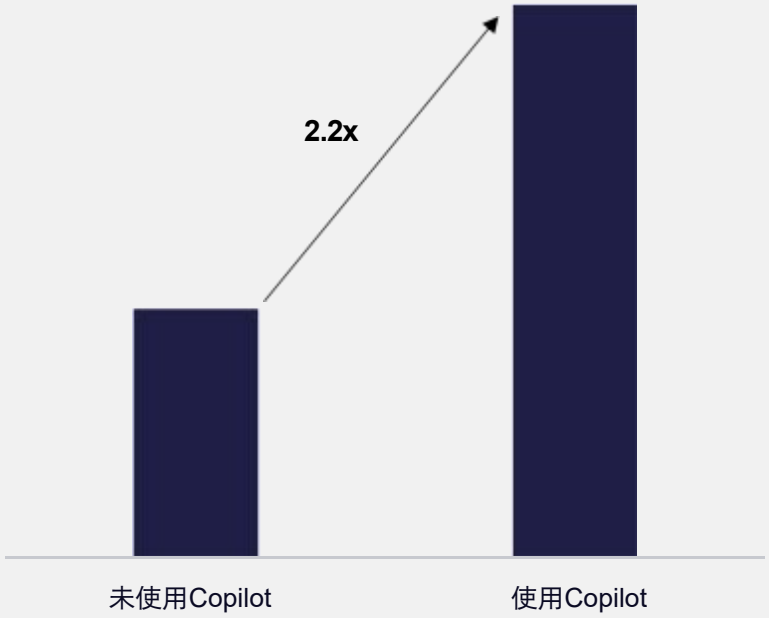


Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of data sources, which are available upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

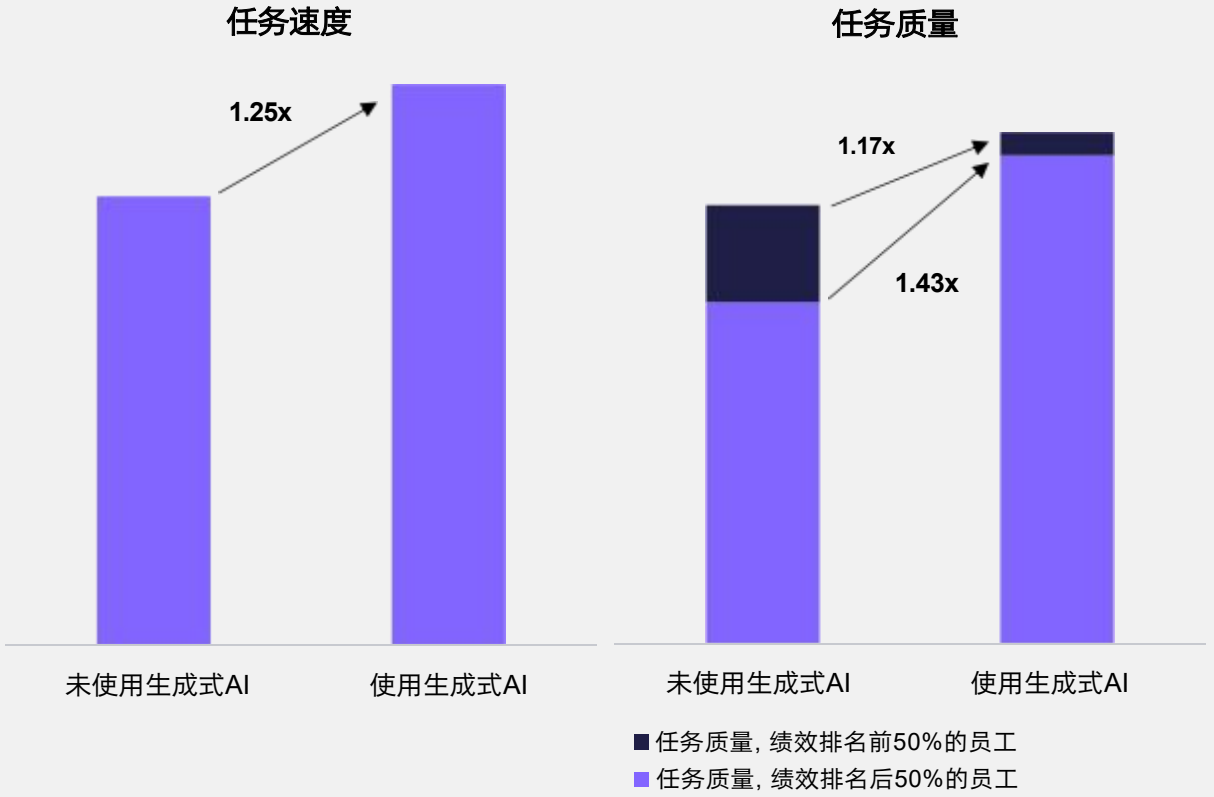
人工智能已经显著提高了生产力

像GitHub Copilot和Replit AI这样的编码助手是早期的成功案例，它们提高了软件开发人员的生产力和工作满意度。人工智能驱动的助理正在提高知识型员工的绩效，有趣的是，与高绩效员工相比，表现不佳的员工受益更多。

2023年开发人员使用Github Copilot进行编码任务的生产力



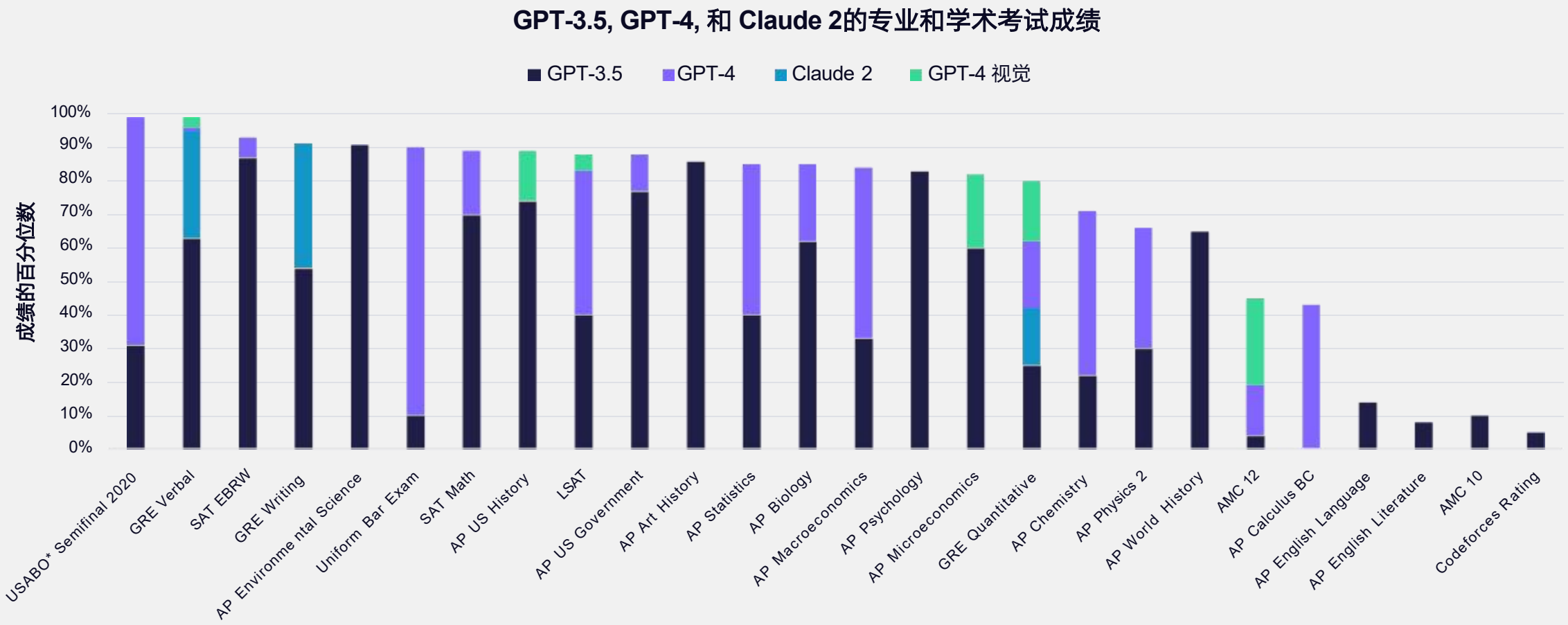
2023年使用生成式AI的顾问的生产力



Sources: ARK Investment Management LLC, 2024. The data used to analyze productivity were collected from several different studies with varying numbers of participants and definitions of task quality. The sources used are Dell' Acqua et al. 2023 and GitHub 2022. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

基础模型正在跨领域改进

凭借更大的训练数据集和更多参数，GPT-4的表现明显优于GPT-3.5。越来越多的基础模型变得 “多模态”——支持文本，图像，音频和视频——不仅更具动态性和用户友好性，而且性能更高。



*USA Biology Olympiad, a prestigious national competition testing high school students in biology. Sources: ARK Investment Management LLC, 2024, based on data from OpenAI and Anthropic as of Jan. 9, 2024.
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Past performance is not indicative of future results.

文本到图像模型正在重塑图形设计

在多伦多大学的研究人员推出第一个现代文本到图像模型八年后，图像模型的输出现在可以与专业平面设计师相媲美。人类设计师可以在几个小时内以数百美元的价格创建一个图像——比如一群大象穿过绿色的草地。文生图模型只要花费几分钱就可以在几秒钟内生成相同的图形。

像Adobe Photoshop这样的专业应用程序和像Lensa和ChatGPT这样的消费者应用程序正在将图像模型集成到他们的产品和服务中。

Q　一群大象走过一片绿色的草地

February 2016
alignDRAW

February 2022
Midjourney v1

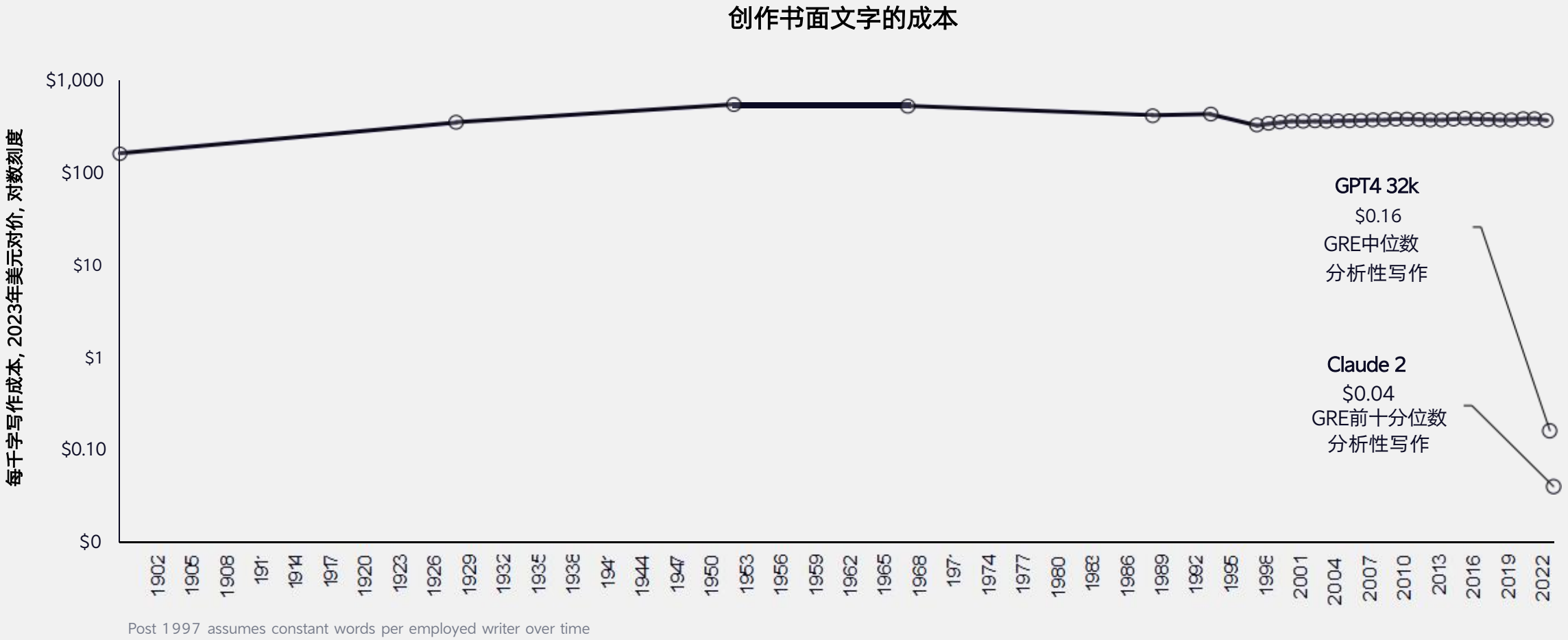
November 2022
Midjourney v4

December 2023
Midjourney v6

Sources: ARK Investment Management LLC, 2024. Images sourced from Masimov et al. 2016 and Midjourney. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

创作书面文字的成本骤降

在过去的一个世纪中，创作书面内容的成本实际上一直相对稳定。在过去的两年中，随着LLM的写作质量提高，成本骤降。

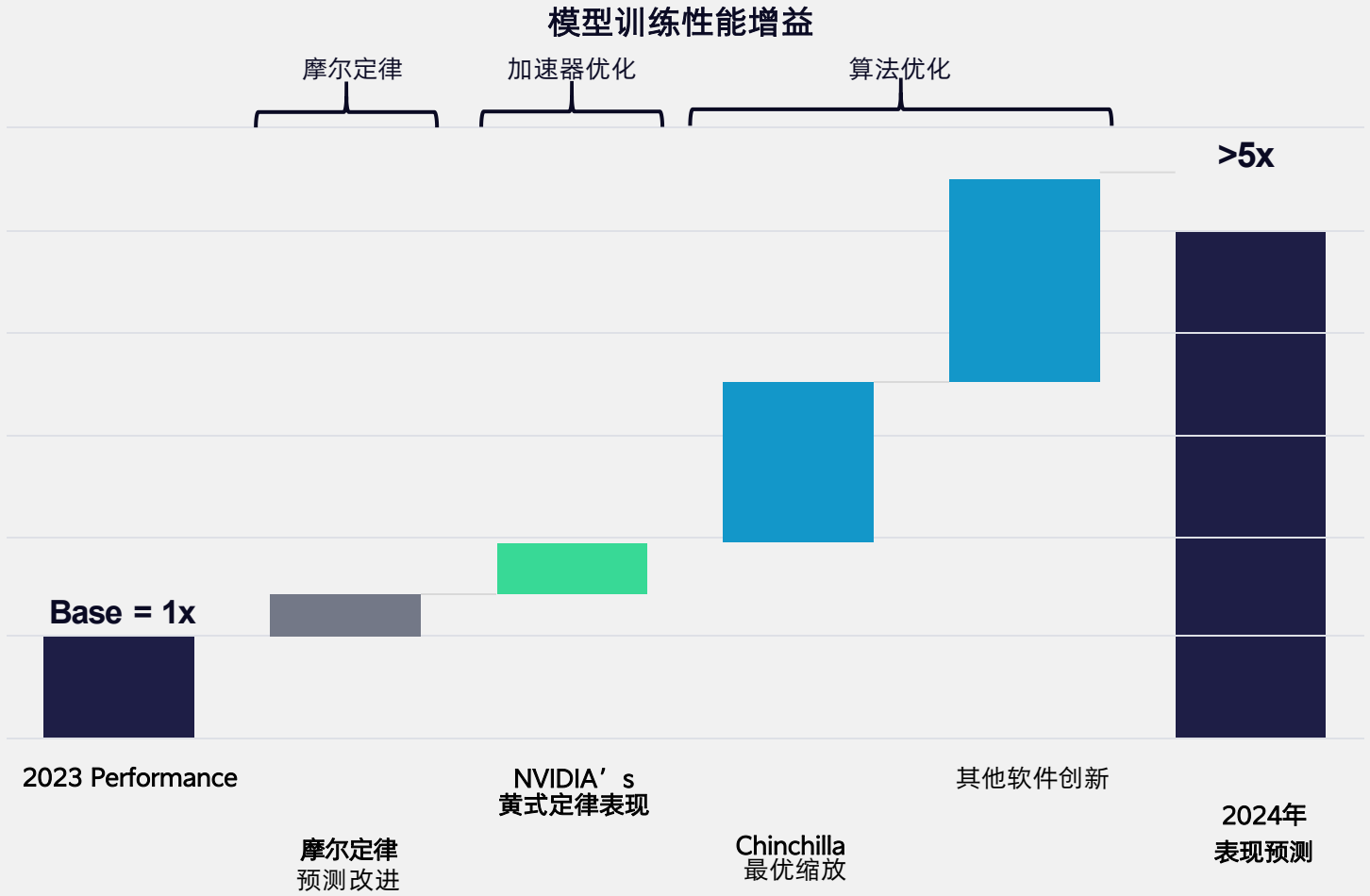


Post 1997 assumes constant words per employed writer over time

Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of data sources as of Jan 9, 2024, which are available upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

AI训练的表现正在迅速提高

人工智能研究人员正在训练和推理、硬件和模型设计方面进行创新，以提高性能和降低成本。



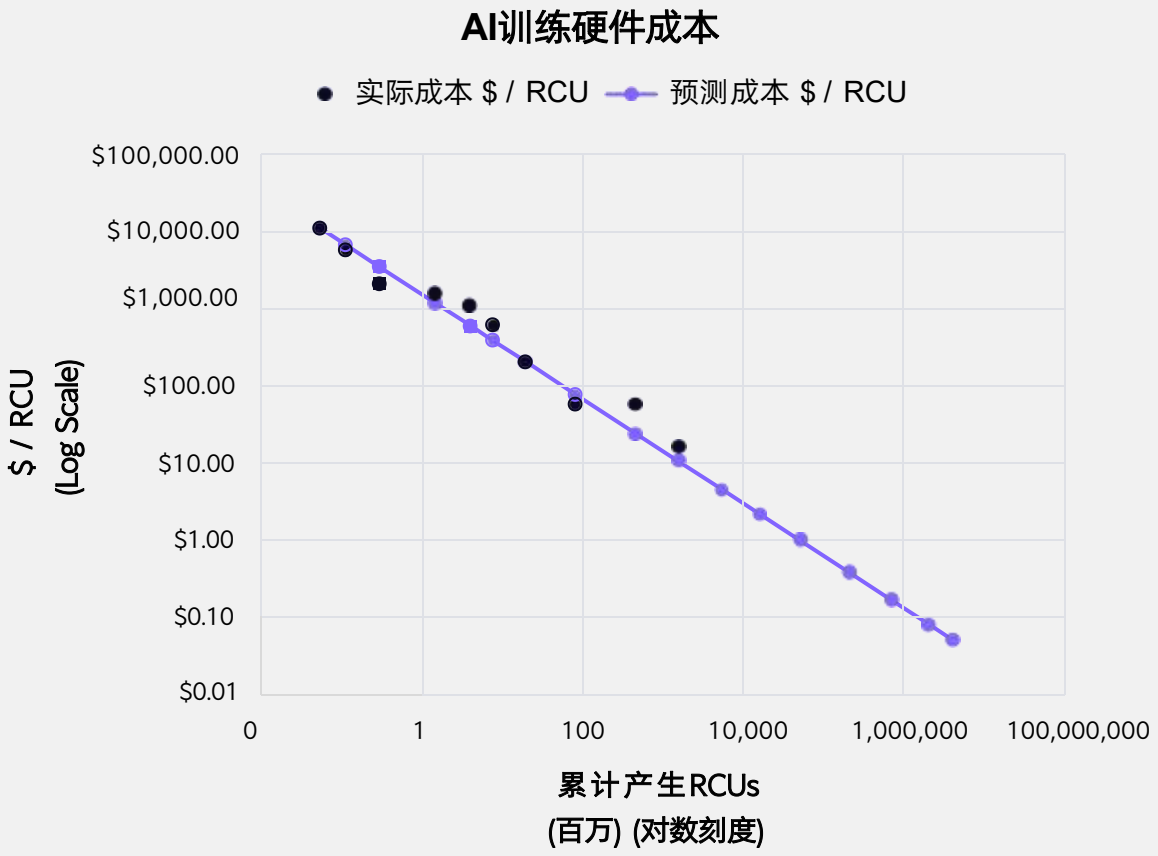
其他算法创新

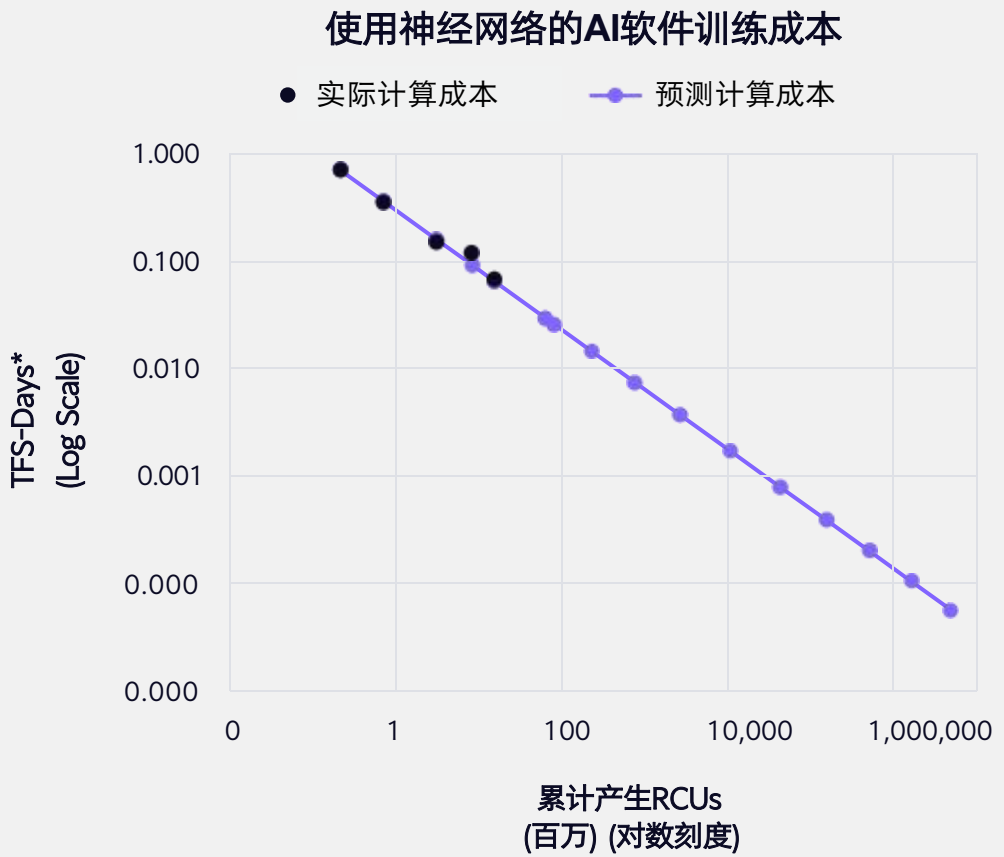
- Llama2表明LLMs的卓越写作能力从根本上是由人类反馈强化学习(RLHF) 驱动的
- 优化的提示词可以比人类提示词表现提升50%
- 推测性解码在某些模型上加快了2-3x的推理速度
- Flash Attention 2在GPT模型中产生2.8倍的训练加速

Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of data sources, including Benaich 2023, Touvron et al. 2023, Yang et al. 2023, Leviathan et al. 2022, and Dao 2023, which are available upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

训练成本继续以每年75%的速度下降

根据赖特定律，加速计算硬件的改进将使AI相对计算单元 (RCU) 的生产成本每年降低53%。而算法模型的增强可以进一步带来每年47%的训练成本下降。换句话说，到2030年，硬件和软件的融合可以使人工智能训练成本以每年75%的速度下降。

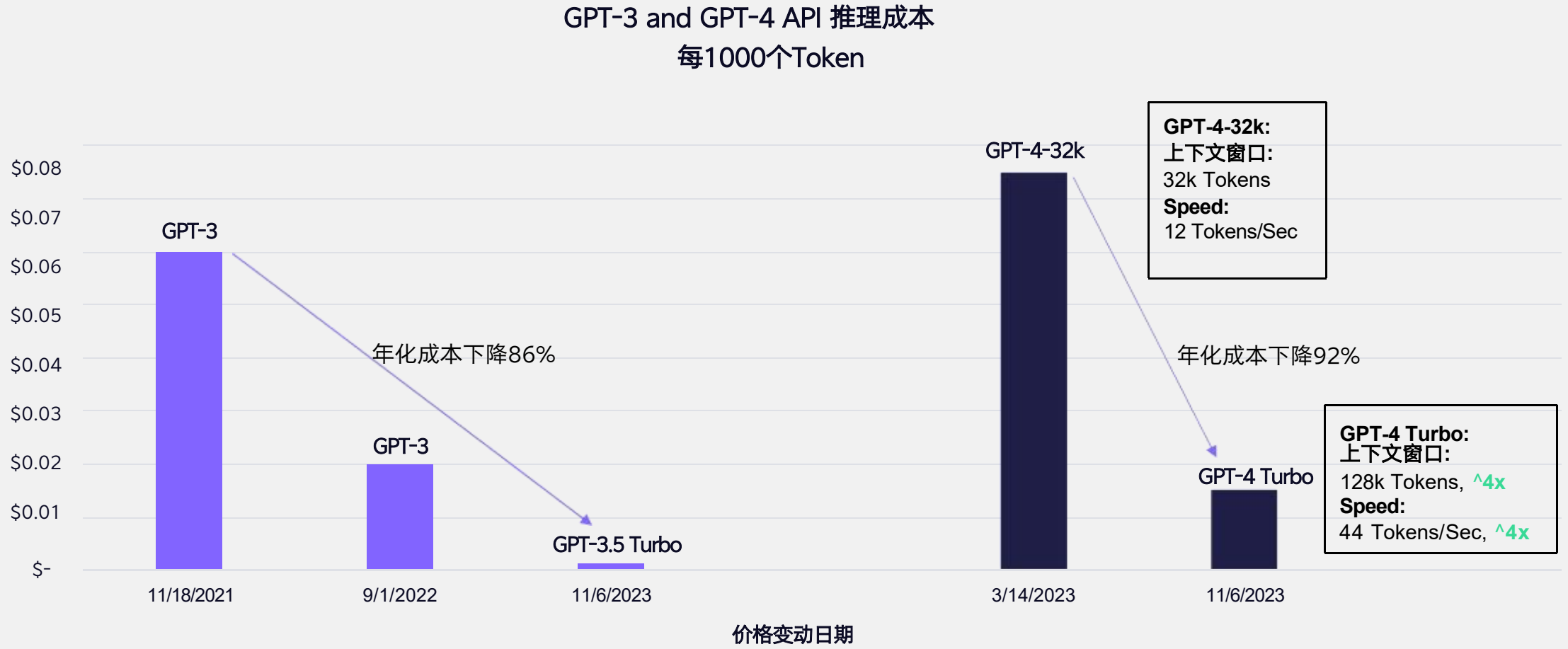




*TFS-Days is a measure of compute required to train a model. Wright's Law states that for every cumulative doubling of units produced, cost will fall by a constant percentage. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of data sources as of Jan. 9, 2024, which are available upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

随着生产用例的出现，人工智能的重点正在转向推理成本

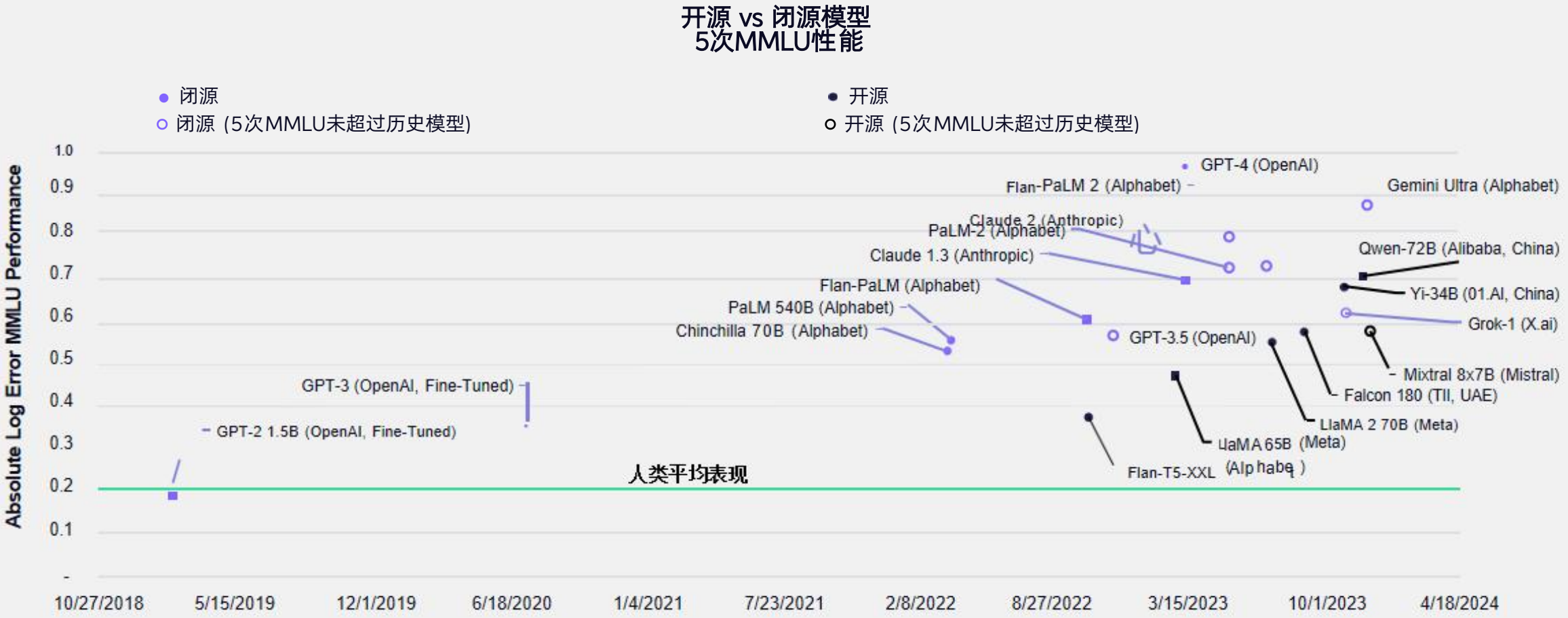
在最初专注于LLM训练成本优化之后，研究人员现在正在优先考虑推理成本。基于企业级用例，推理成本似乎以每年约86%的速度下降，甚至比训练成本下降还要快。如今，与GPT-4 Turbo相关的推理成本低于一年前的GPT-3。



Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of data sources, including Patel and Kostovic 2023, and ARK Investment Management LLC 2023, which are available upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

开源社区正在与私有模型竞争

挑战来自OpenAI和Google的闭源模型，开源社区及其冠军企业Meta正在使生成式AI的访问民主化。总的来说，开源模型的性能比闭源模型的性能提高得更快，这得益于最近来自中国的模型。



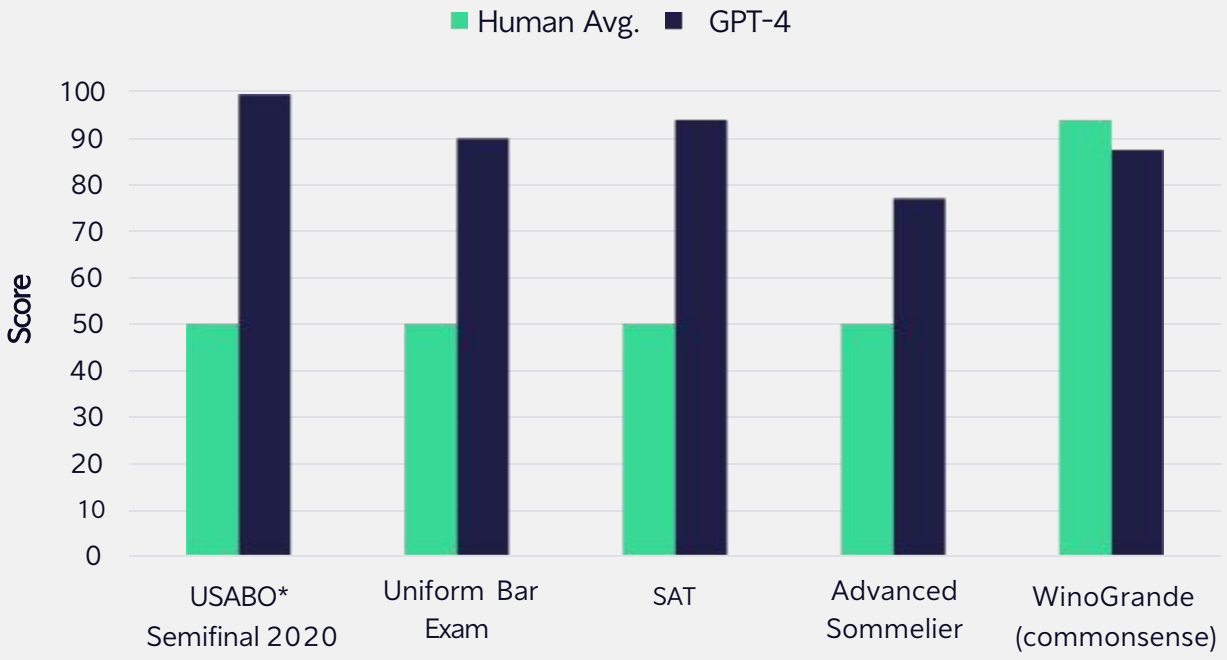
Note: The chart's trendlines are fit to the most performant open- or closed-source models on 5-shot MMLU (Massive Multitask Language Understanding) at the time of their release. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of data sources as of Jan. 9, 2024, which are available upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

语言模型性能的进步需要细致入微的技术

从SAT到高级侍酒师考试，GPT-4在标准化教育考试中的表现明显优于普通人。然而，根据WinnoGrande的衡量，它在常识推理方面落后于人类水平的能力。

斯坦福大学的框架-语言模型的整体评估 (HELM)-是最全面的，不断更新的评估方法之一，已针对73个场景和65个指标的组合测试了80多个模型。

部分GPT-4基准测试结果



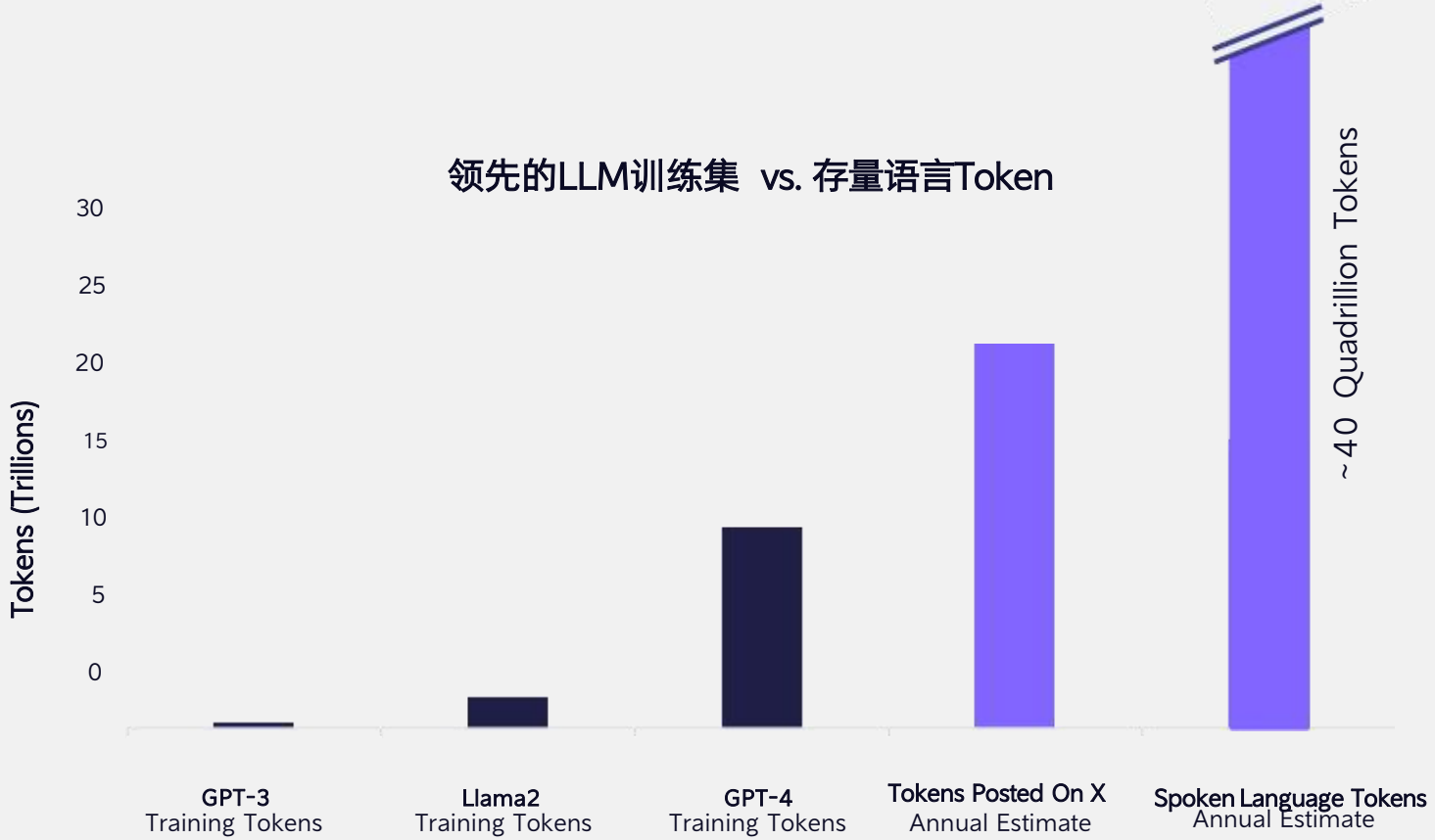
HELM评估指标

准确性	与实况数据的比较
校准	概率分布评估
鲁棒性	带有扰动输入的压力测试
公平性	跨不同组的性能
偏差	偏斜的决策模式分析
毒性	有害含量检出率
效率	任务执行期间的资源使用情况

*USA Biology Olympiad, a prestigious national competition testing high school students in biology. Sources: ARK Investment Management LLC, 2024, based on data from Life Architect 2023 and Bomasani et al. 2023 as of Jan. 9, 2024. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

LLm是否会耗尽数据，从而性能受限？

计算能力和高质量的训练数据似乎是模型性能的主要贡献者。随着模型的增长和需要更多的训练数据，缺乏新数据会导致模型性能停滞不前吗？Epoch AI估计，到2024年，书籍和科学论文等高质量的语言/数据源可能会耗尽，尽管仍然存在大量未开发的视觉数据。



未开发的数据源

- 每年口语的30万亿个单词
- 语音生成文本工具，捕获每天说的大约80万亿个单词
- 增强原始数据的合成数据
- 自动出租车，卡车，无人机和其他生成大量物理世界数据的机器人

Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of data sources as of Jan 9, 2024, which are available upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

定制的AI产品应该享有更多的定价权

随着开源替代品的出现和成本的下降，为最终用途应用定制人工智能的软件供应商应该能够更容易地将它们货币化。相反，简单的生成式AI应用程序可能会迅速商品化。

- 水平的，商品化工具
- < 5% 价值捕获
- 案例：AI会议总结

- 垂直化，高度差异化工具
- 20%+ 价值捕获
- 案例: 自动驾驶网约车

Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of data sources, including Sirohi 2023 and McKinsey & Co. 2023 as of Jan. 9, 2024, which are available upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

加速知识工作者生产力的增长代表着潜在的数万亿美元的机会

加速知识工作者生产力的增长代表着一个潜在的数万亿美元的机会。到2030年，人工智能有可能使知识型职业中的大多数任务自动化，从而大大提高普通工人的生产力。

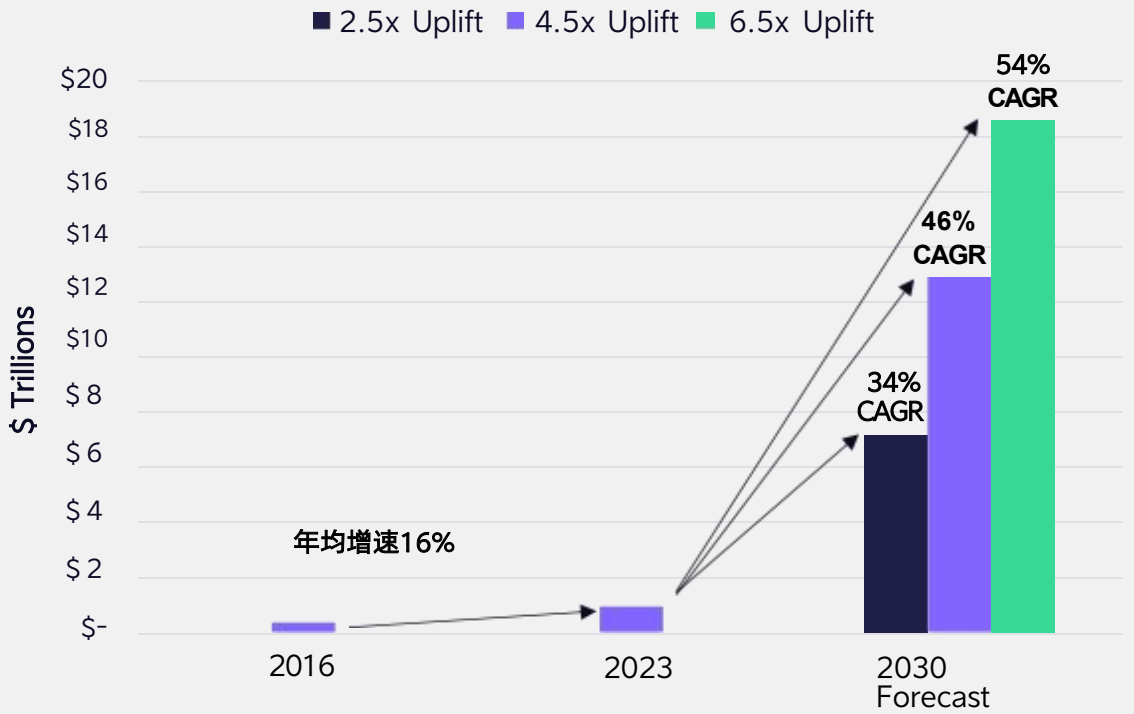
自动化和加速知识工作任务的软件解决方案应该是主要受益者。

2030年AI潜在市场 (TAM) 总量预测

软件供应商价值捕获占生产力收益的百分比

生产力提升（倍）	1%	10%	20%
2.5	$0.7T	$7T	$14T
4.5	$1.3T	$13T	$26T
6.5	$1.9T	$19T	$37T

AI对软件增长的影响



CAGR = Compound Annual Growth Rate. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of data sources, including McKinsey & Co. 2023, which are available upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Research By: Yassine Elmandjra, Director of Digital Assets; David Puell, Research Associate

比特币配置

增加比特币在投资组合中的比重

Sources: ARK Investment Management LLC, 2024. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

重要信息

比特币是一个相对较新的资产类别，比特币市场受到快速变化和不确定性的影响。比特币在很大程度上不受监管，比特币投资可能比更受监管的投资更容易受到欺诈和操纵。比特币面临着独特而重大的风险，包括价格大幅波动、缺乏流动性和盗窃。

比特币受到价格快速波动的影响，包括影响者和媒体的行动和声明，比特币供求的变化以及其他因素。无法保证比特币将长期保持其价值。

以下幻灯片上提供的信息基于ARK的研究，并非旨在作为投资建议。ARK研究比特币作为投资的效用，以确定其潜在的未来价值，如以下幻灯片所示。该材料不明确或隐含地构成ARK提供的任何服务或产品，投资者应自行确定特定的投资管理服务是否适合其投资需求。ARK强烈鼓励任何考虑投资比特币或任何其他数字资产的投资者在投资前咨询金融专业人士。所有关于比特币的声明都是ARK持有的严格信念和观点，而不是ARK购买，出售或持有比特币的建议。

历史结果不是未来结果的迹象。

重要术语和概念

以下幻灯片中介绍的研究包含一些读者可能不熟悉的术语和概念，因此下面我们提供解释以帮助评估研究提供基础。

- 夏普比率是衡量投资或投资组合风险调整后收益的一种著名且广受好评的指标，这表明一项投资与无风险投资的回报率相比有多好，比如美国。美国政府国债或票据。夏普比率的计算方法是先计算投资组合或单项投资的预期收益率，再减去无风险收益率。通常情况下，考虑到风险，较高的夏普比率表示良好的投资业绩，而夏普比率小于1则被认为不及好。夏普比率在我们的研究中被用来确定，假设，在什么样的分配百分比比特币将最大化由其他常用资产类别的整体投资组合的风险调整后的回报。

- 有效边界是在确定的风险水平下提供最高预期收益或在给定预期收益水平下提供最低风险的一组最佳投资组合。换句话说，它以图形方式表示了在所承担的风险下收益最大化的投资组合。低于有效边界的投资组合被认为是次优的，因为它们不能为风险水平提供足够的回报，而聚集在有效边界右侧的投资组合也被认为是次优的，因为它们对于定义的收益率具有更高的风险水平。本节使用有效前沿图来说明，与由单一资产类别组成的投资组合相比，我们配置比特币构建的模拟投资组合位于有效前沿被认为是次优的。

- 复合年增长率（“CAGR”）是假设在此期间利润再投资，投资在几年中的平均年增长率。换句话说，它将一项投资在若干年内的总回报率分解为一个单一的平均回报率。CAGR通常用于比较较长时间内的资产或投资组合，方法是使用平均值，而不是每年单独分析，因为每年的回报可能不均衡。我们在研究中使用CAGR来确定投资组合或资产类别在一段时间内的预期回报，通常是5年。

- 标准差是投资组合中风险或波动性的度量，它表示投资将偏离其预期收益的程度。波动率越高的投资意味着标准差越高，因此风险也越大。我们使用标准差来确定与某些风险水平相称的回报金额。

Sources: ARK Investment Management LLC, 2024 Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

像比特币这样的数字资产是一种新的资产类别

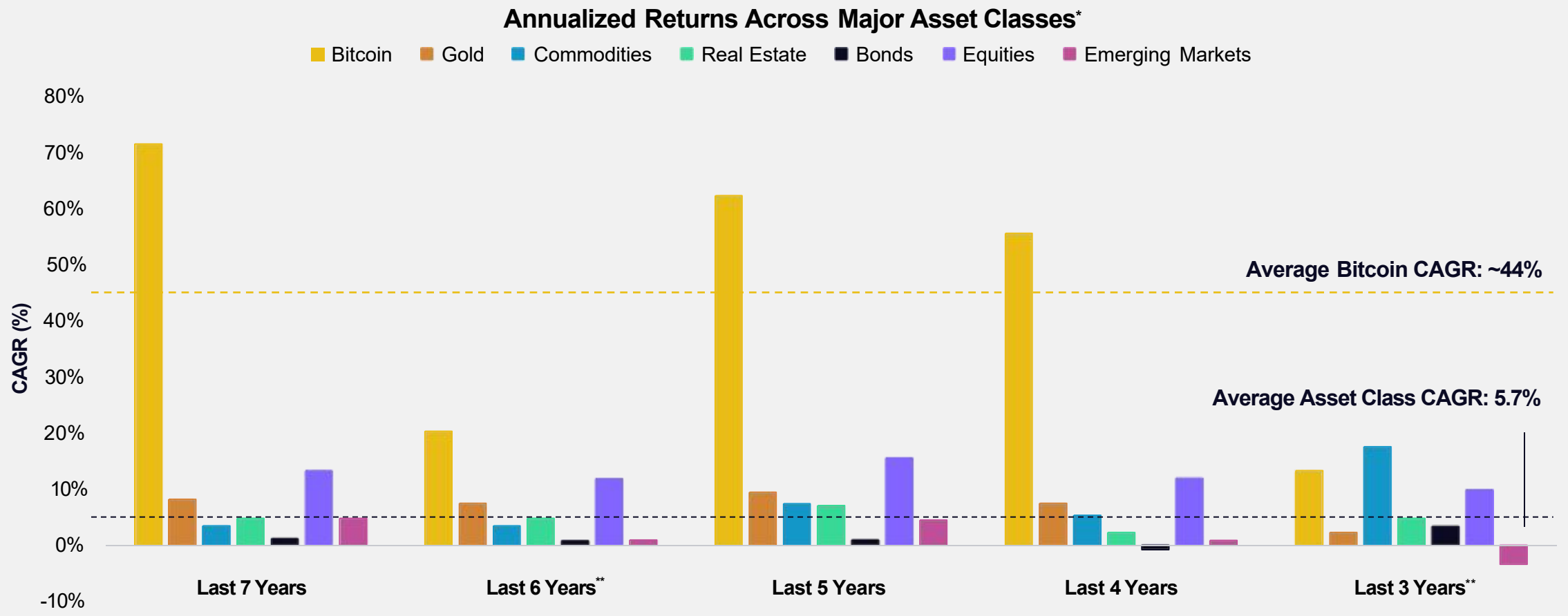
根据ARK的研究，比特币已经成为一个独立的资产类别，值得在机构投资组合中进行战略配置。

	比特币	大宗商品 (包含黄金)	房地产	债券	股票 (包含新兴市场)
历史	在2009年全球金融危机期间由个人或团队以化名Satoshi Nakamoto创建	起源可以追溯到数千年前，像黄金这样的商品被用作价值储存	已知最早的私有财产权形成于古希腊和罗马	已知最早的债券是由威尼斯市在12世纪发行的，但债务/贷款的概念可以追溯到古代美索不达米亚	起源可以追溯到17世纪阿姆斯特丹证券交易所的建立
可投资性	高度流动性，任何人都可以访问互联网。在加密交易所和现货etf上交易	流动性相当高，可通过银行和经纪人通过实物硬币和etf获得	非流动性，直接购买或通过REITs购买	高度流动性，在债券市场上交易，可通过经纪人获得	高度流动性。在证券交易所交易，可通过经纪人获得
价值基础	与对由开源软件驱动的分散、独立货币系统的需求挂钩	受全球经济状况影响，与供需挂钩	与利率、房地产市场和当地经济挂钩	与利率政策和信用风险挂钩	与未来现金流的预期挂钩
回报的相关性	与传统资产类别相关性低	与资产类别呈负相关，特别是在经济不确定性期间	通常与股票和债券的相关性较低至中等	最近与股票呈负相关，但在整个经济史上并不总是如此	与全球经济健康和市场情绪相关
监管	分散和社区驱动，利用开源软件进行决策	受采矿法规管辖	受地方和国家财产法管辖	受政府或公司设定的发行条款约束	受公司管理和政府机构监管
用例	稀缺的数字价值存储，其货币原生于互联网	工业活动、财富保值和套期保值	个人住宅、租金收入	固定收益投资，定期支付利息，到期返还本金	公司所有权，通常具有投票权和股息

Sources: ARK Investment Management LLC, 2024 For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

在更长的时间范围内，比特币的表现优于所有主要资产

在过去的七年里，比特币的年化回报率平均为44%，而其他主要资产的年化回报率平均为5.7%。



*Asset classes are represented by the following instruments: SPDR S&P 500 ETF Trust (SPY, equities), Vanguard Total Bond Market Index Fund Investor Shares (VBMFX, bonds), Vanguard Real Estate Market Index Fund Investor Shares (VGSIX, real estate), SPDR Gold Trust (GLD, gold), iShares S&P GSCI Commodity-Indexed Trust ETF (GSG, commodities), and Vanguard Emerging Markets Stock Index Fund Investor Shares (VEIEX, emerging markets). The performance used to represent each asset class reflects the net asset value (NAV) performance of each ETF/fund for the time periods shown. ** "Last 6 Years" includes 2018, 2021, and 2022; "Last 3 Years" includes 2021 and 2022, all years of market downturn or relatively low returns for bitcoin. Sources: ARK Investment Management LLC, 2024, based on data and calculation from PortfolioVisualizer.com, with bitcoin price data from Glassnode, as of December 31, 2023. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

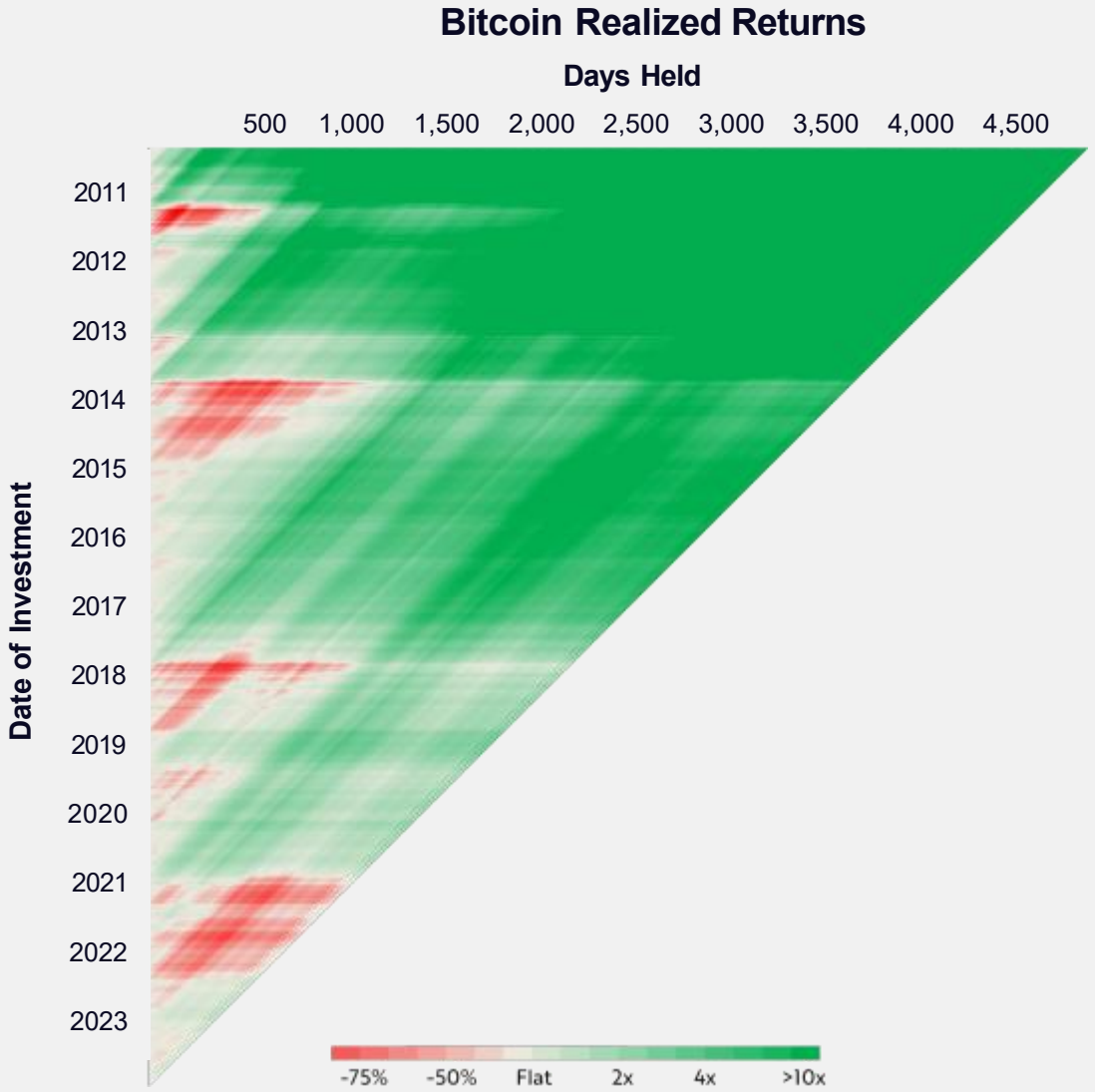
一般来说，具有长期时间跨度的比特币投资者随着时间的推移而受益

“持有时间，而不是何时持有”*

比特币的波动性可能会混淆其长期回报。虽然短期内可能会出现大幅升值或贬值，但长期投资范围一直是投资比特币的关键。

而不是“何时”，更好的问题是“多长时间？”

从历史上看，购买并持有比特币至少5年的投资者已经获利，无论他们何时购买。



*Adage first put forth in this configuration by Mizuho Financial Group. Sources: ARK Investment Management LLC, 2024, based on data from Glassnode as of December 31, 2023. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

比特币与传统资产的相关性很低

从历史上看，比特币的价格走势与其他资产类别的价格走势并不高度相关。在过去的五年中，比特币相对于传统资产类别的回报率的相关性平均仅为0.27。

Asset Class Correlation Matrix[1,2]

(12-Month As Of December 2023)

High correlation: coefficient value lies between ± 0.66 and ±1
Moderate correlation: coefficient value lies between ± 0..4 and ± 0.66
Low correlation: coefficient value lies below ± 0.4

	Bitcoin	Gold	Commodities	Real Estate	Bonds	Equities	Emerging Markets
Bitcoin		0.2	0.1	0.4	0.26	0.41	0.23
Gold	0.2		-0.03	0.28	0.46	0.26	0.34
Commodities	0.1	-0.03		0.42	-0.12	0.43	0.5
Real Estate	0.4	0.28	0.42		0.57	0.86	0.68
Bonds	0.26	0.46	-0.12	0.57		0.48	0.46
Equities	0.41	0.26	0.43	0.86	0.48		0.73
Emerging Markets	0.23	0.34	0.5	0.68	0.46	0.73	
AVERAGE	**0.27**	**0.25**	**0.21**	**0.53**	**0.35**	**0.53**	**0.49**

[1] A correlation of 1 connotes that assets perfectly move in tandem; 0 means their movement is completely independent from each other; -1 suggests that they move in perfectly opposite directions. [2] Asset classes are represented by the following instruments: SPDR S&P 500 ETF Trust (SPY, equities), Vanguard Total Bond Market Index Fund Investor Shares (VBMFX, bonds), Vanguard Real Estate Market Index Fund Investor Shares (VGSIX, real estate), SPDR Gold Trust (GLD, gold), iShares S&P GSCI Commodity-Indexed Trust ETF (GSG, commodities), and Vanguard Emerging Markets Stock Index Fund Investor Shares (VEIEX, emerging markets). The performance used to represent each asset class reflects the net asset value (NAV) performance of each ETF/fund for the time periods shown. Sources: ARK Investment Management LLC, 2024, based on data and calculation from PortfolioVisualizer.com, with bitcoin price data from Glassnode, as of December 31, 2023. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

比特币可以在最大化风险调整后的回报方面发挥重要作用

专注于传统资产类别的波动率和收益情况，ARK的研究表明，寻求最大化风险调整后收益1的投资组合在2023年会配置19.4%到比特币中。

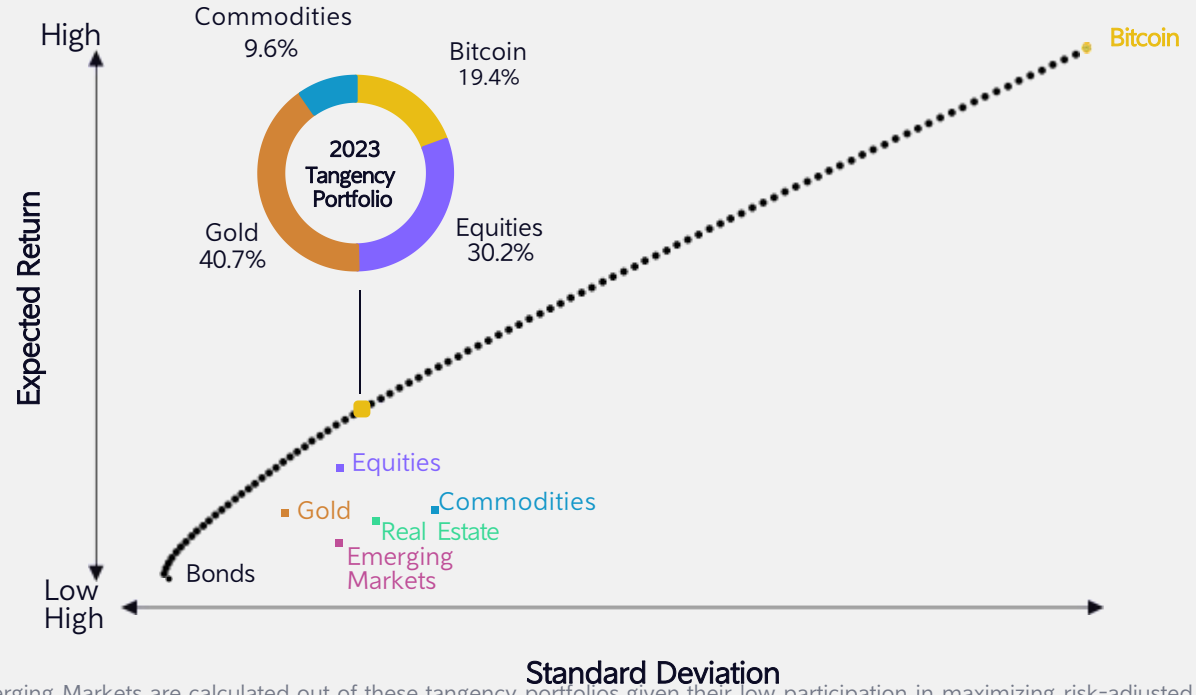
Simulated Optimal Portfolio Allocation Targets By Year[2,3]

(Rolling 5-Year As Of End Of Every Year[6])

	Bitcoin	Gold	Commodities	Bonds	Equities
2015	0.5%	0%	0%	82.5%	16.9%
2016	0.9%	0%	0%	62.1%	36.9%
2017	0.9%	0%	0%	58.7%	40.3%
2018	2.4%	0%	0%	77.3%	20.2%
2019	3.9%	1.4%	0%	70.4%	24.2%
2020	4.3%	4.1%	0%	75.6%	15.8%
2021	4.7%	7.3%	0%	65.3%	22.6%
2022	6.2%	52.8%	9.1%	0%	31.8%
2023	**19.4%**	**40.7%**	**9.6%**	**0%**	**30.3%**

2023 Simulated Portfolio Optimization[3,4,5]

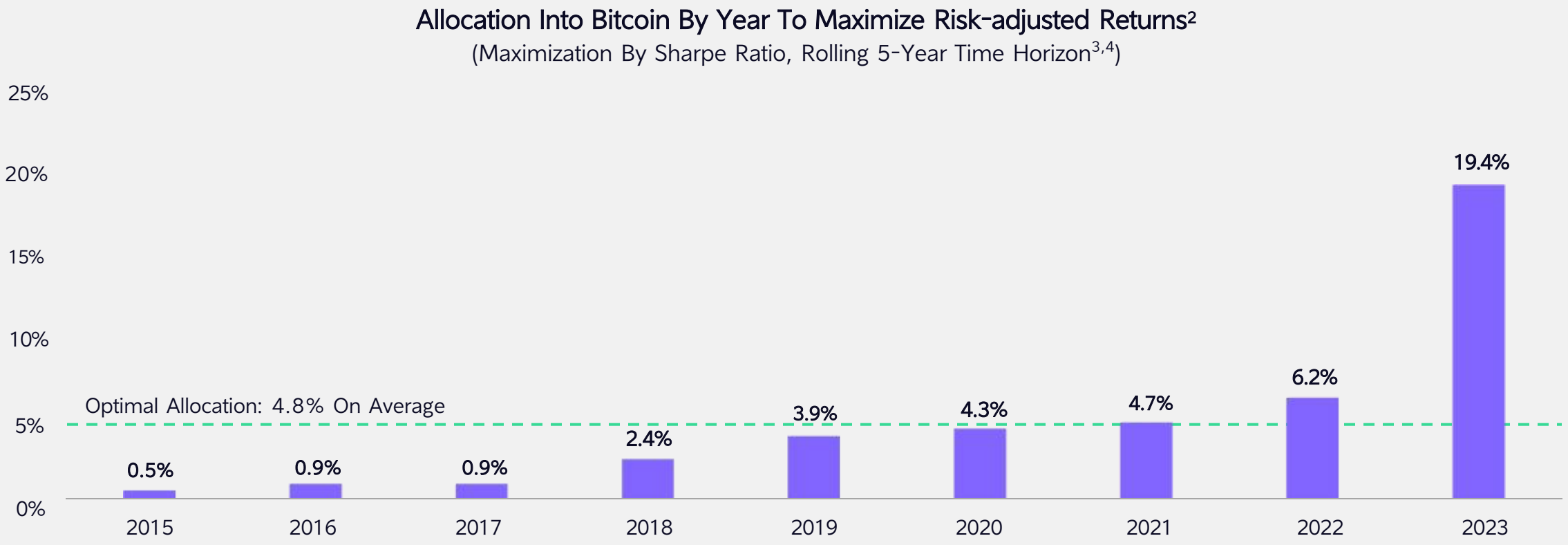
Based On Monthly Asset Class Returns (No Limit, Rolling 5-Year[6])



[1] Measurement of returns of an asset against its risk (in this case, volatility). [2] Real Estate and Emerging Markets are calculated out of these tangency portfolios given their low participation in maximizing risk-adjusted returns relative to the other asset classes included in this table. [3] Asset classes are represented by the following instruments: SPDR S&P 500 ETF Trust (SPY, equities), Vanguard Total Bond Market Index Fund Investor Shares (VBMFX, bonds), Vanguard Real Estate Market Index Fund Investor Shares (VGSIX, real estate), SPDR Gold Trust (GLD, gold), iShares S&P GSCI Commodity-Indexed Trust ETF (GSG, commodities), and Vanguard Emerging Markets Stock Index Fund Investor Shares (VEIEX, emerging markets). The performance used to represent each asset class reflects the net asset value (NAV) performance of each ETF/fund for the time periods shown. [4] This simulation, also known as "efficient frontier", is a set of theoretical investment portfolios expected to provide the highest returns at multiple levels of risk. [5] The dots under the efficient frontier in the chart represent portfolios comprised of a single asset class. [6] 5 years were used since, in our view, they represent a sample of a long-term time horizon. Sources: ARK Investment Management LLC, 2024, based on data and calculation from PortfolioVisualizer.com, with bitcoin price data from Glassnode, as of December 31, 2023. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

基于5年滚动，如果配置比特币可最大化在过去9年中风险调整后的回报

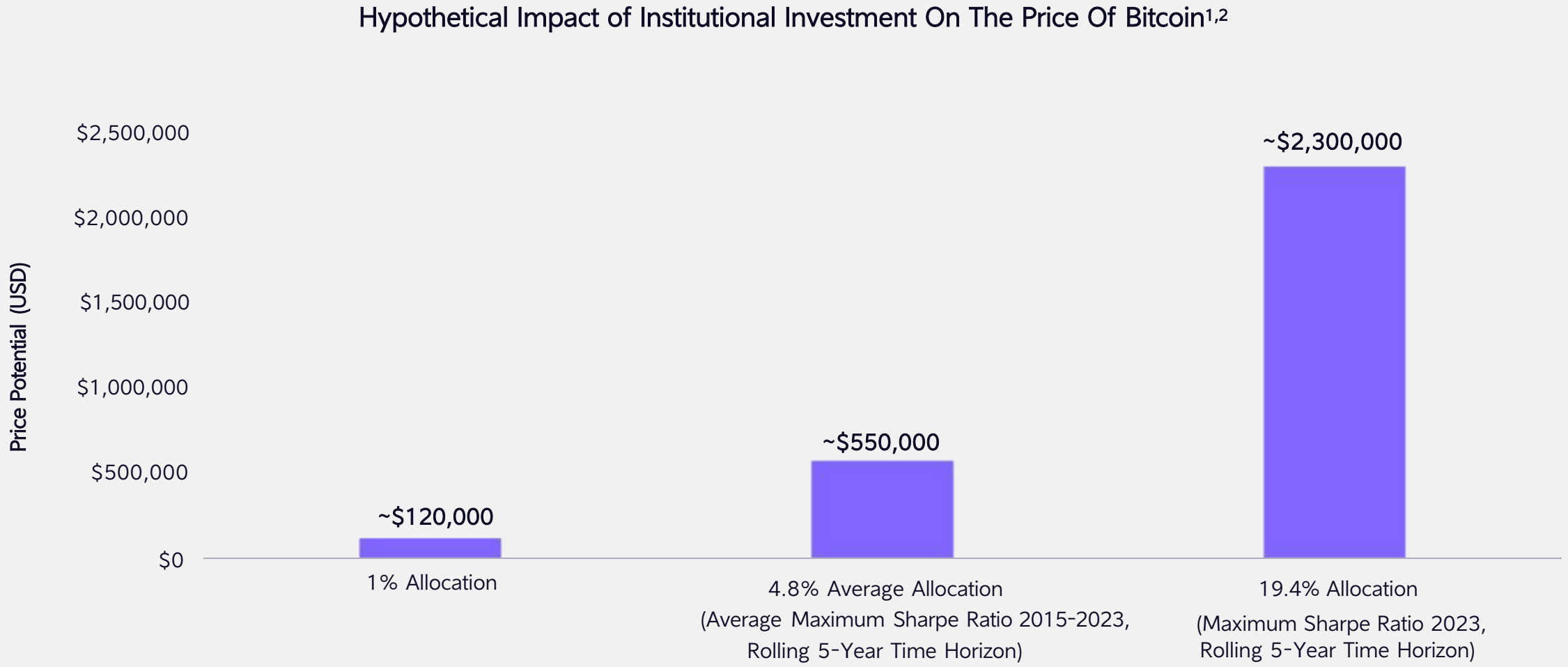
根据我们的分析，在2015年，最大化风险调整后收益1——5年期水平为3——的最优配置应该是0.5%。此后，在相同的基础上，比特币的平均配置比例为4.8%，仅在2023年，比特币的平均配置比例为19.4%。



[1] Risk-adjusted returns given by the Sharpe ratio, which divides expected returns minus the risk-free rate by the standard deviation of the asset. [2] For asset class representation in this calculation, please refer to the previous slide. [3] 5 years were used since, in our view, they represent a sample of a long-term time horizon.. Sources: ARK Investment Management LLC, 2024, based on data and calculation from PortfolioVisualizer.com, with bitcoin price data from Glassnode, as of December 31, 2023. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

对比特币进行最佳配置会产生什么影响？

基于250万亿美元的全球可投资资产对比特币的配置将对价格产生重大影响。



[1] This chart was calculated by dividing each percentage allocation of the estimated global investable asset base of $250 trillion USD (Chung 2021) by the fully diluted expected bitcoin supply of 21 million. When dividing the investable asset base by the bitcoin supply of 19.5 million as of 12/31/2023, the price potential increases to ~$127k (1% allocation), ~$615k (4.8% allocation), and ~$2.5 million (19.4% allocation). [2] Asset classes are represented by the following instruments: SPDR S&P 500 ETF Trust (SPY, equities) and Vanguard Total Bond Market Index Fund Investor Shares (VBMFX, bonds). The performance used to represent each asset class reflects the net asset value (NAV) performance of each ETF/fund for the time periods shown. Sources: ARK Investment Management LLC, 2024, based on data and calculation from PortfolioVisualizer.com, with bitcoin price data from Glassnode, as of December 31, 2023. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Research By:
Yassine Elmandjra
Director of Digital Assets
David Puell
Research Associate

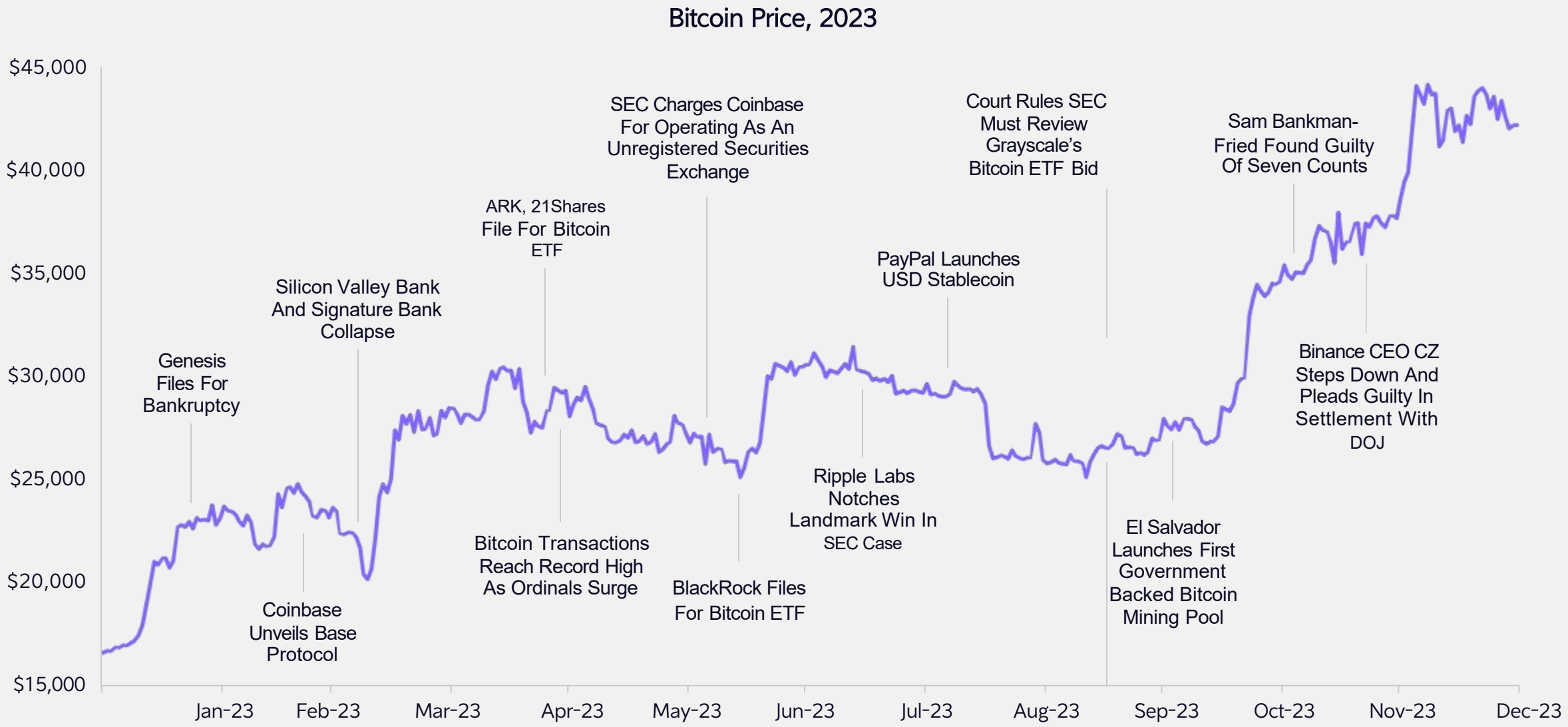
2023年的比特币

展示2022年挑战后的韧性和复苏

本报告为ARK投资出品的年度研究报告，智能小巨人科技进行了编译，仅供学习参考，请勿用于商业用途

Sources: ARK Investment Management LLC, 2024. Information as of December 31, 2023. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

2023年，比特币价格飙升155%，市值增至8270亿美元



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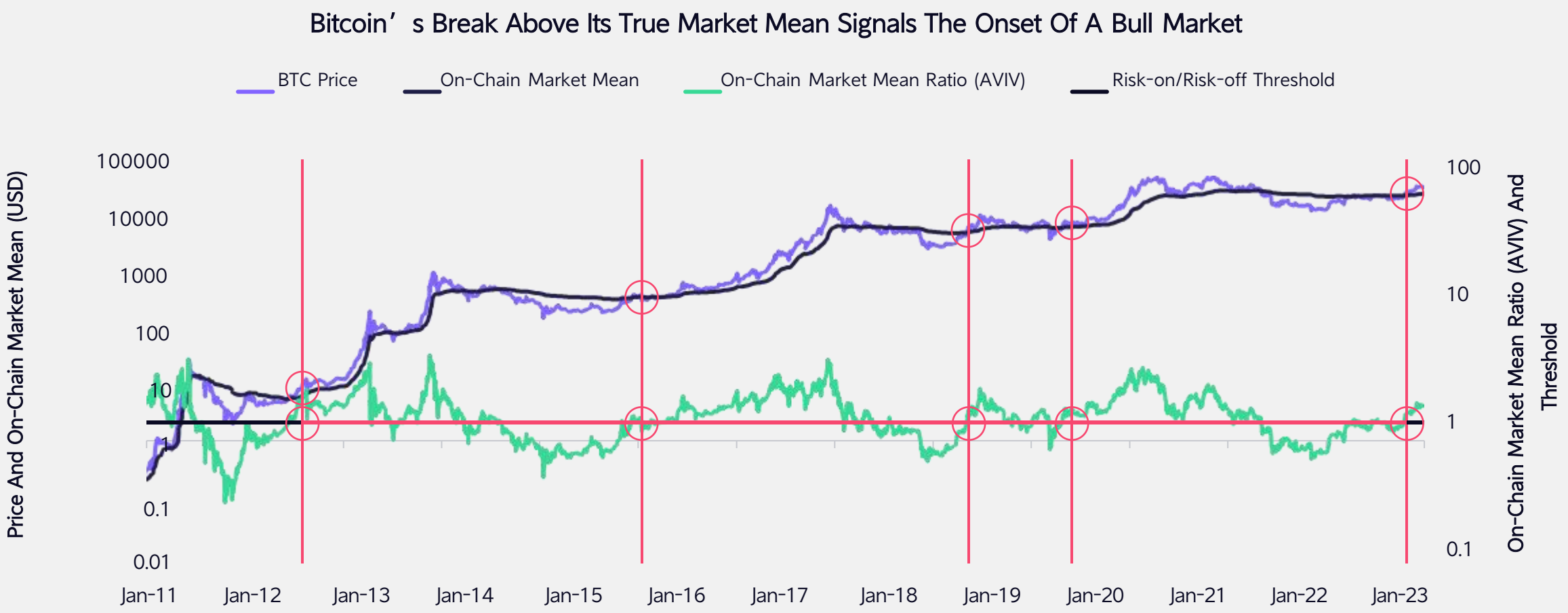
在大约4年内，比特币的价格首次超过其链上市场均值

ARK的原创指标，链上市场均值，一直是比特币市场风险界限的可靠分界点。从历史上看，当比特币价格超过链上市场均值时，通常预示了牛市的早期阶段。



Sources: ARK Investment Management LLC, 2024, based on data from Glassnode as of December 31, 2023. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

2023年为2022年的危机提供了重要答案

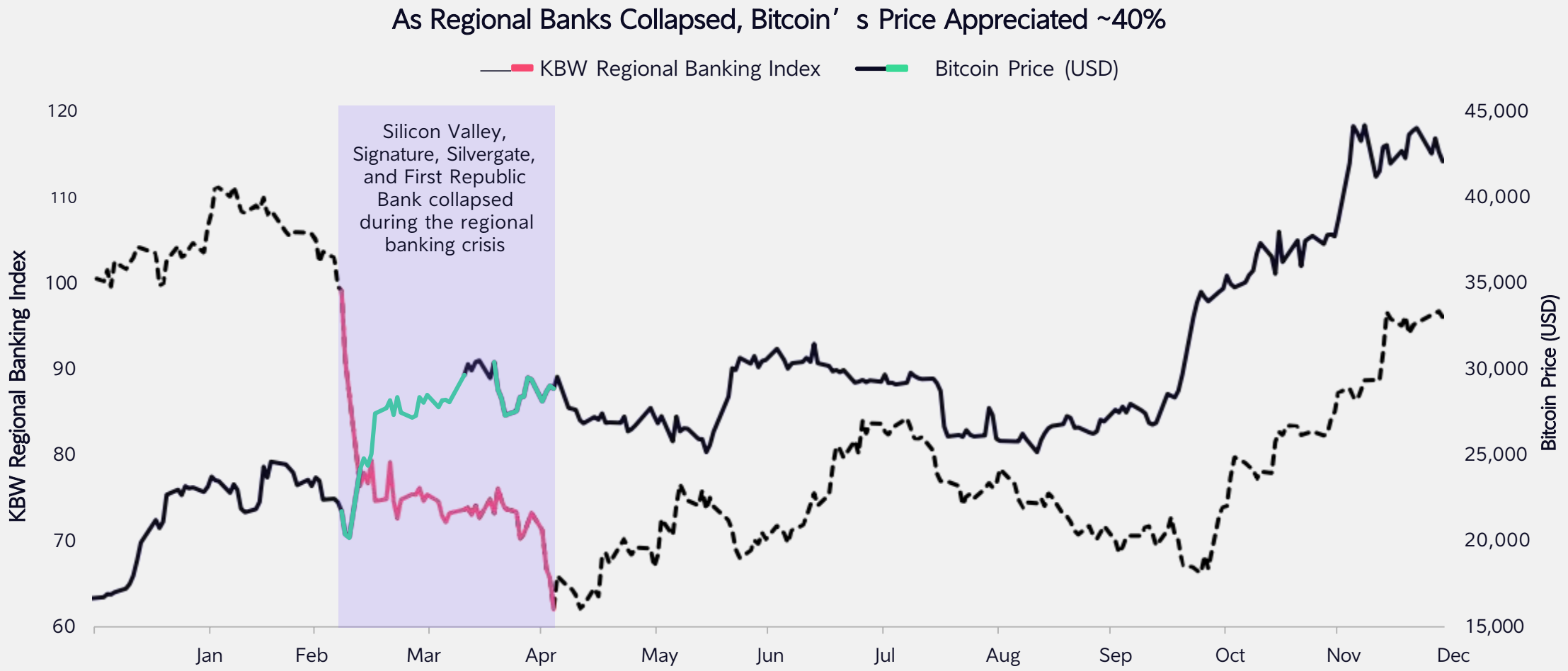
实体	2022年危机	2023年决议
Luna, UST	算法稳定币UST崩溃，导致其姊妹加密货币LUNA大幅抛售，市值超过600亿美元。*	创始人Do Kwon被捕，并在曼哈顿美国地方法院面临八项起诉，而他的初创公司Terraform Labs因策划数十亿美元的证券欺诈而面临SEC民事指控。
三箭资本	LUNA的倒闭导致备受瞩目的对冲基金三箭资本 (3AC) 陷入流动性危机，迫使其破产。	新加坡金融管理局禁止3AC的联合创始人从事资本市场活动长达9年，英属维尔京群岛的一家法院冻结了他们的资产。
Celsius 网络	加密贷款平台Celsius冻结提款，然后申请破产。	一家破产法院批准了Celsius的重组计划，该计划将资产返还给客户，并成立一家专注于采矿和投资的新公司。首席执行官Alex Mashinsky因涉嫌误导客户而面临刑事指控。
FTX	在Coindesk暴露了交易公司Alameda和FTX之间的欺诈性财务纠纷之后，FTX遭受了银行挤兑并倒闭。	纽约南区以与FTX倒闭有关的七项欺诈罪对Sam bankman-fried定罪。一家破产法院批准了FTX房地产公司出售其资产的批准。
BlockFi	BlockFi对FTX的敞口迫使其破产。	BlockFi获得法院批准进行清算，并向债权人提供部分实物偿还。
Genesis	由于对3AC的大量贷款，加密贷款人Genesis宣布破产。	加密贷款人Genesis与母公司DCG达成和解，涉及6.2亿美元的还款。SEC起诉Genesis出售未注册证券。

*This data point is sourced from Corva 2022. Sources: ARK Investment Management LLC, 2024. Information as of December 31, 2023. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Big Ideas 2024—智能小巨人科技编译版

在区域性银行业崩溃期间，比特币是一个避风港

在2023年初，在美国区域性银行的历史性倒闭期间，比特币的价格升值了40%以上，突显了其作为对冲交易对手风险的作用。



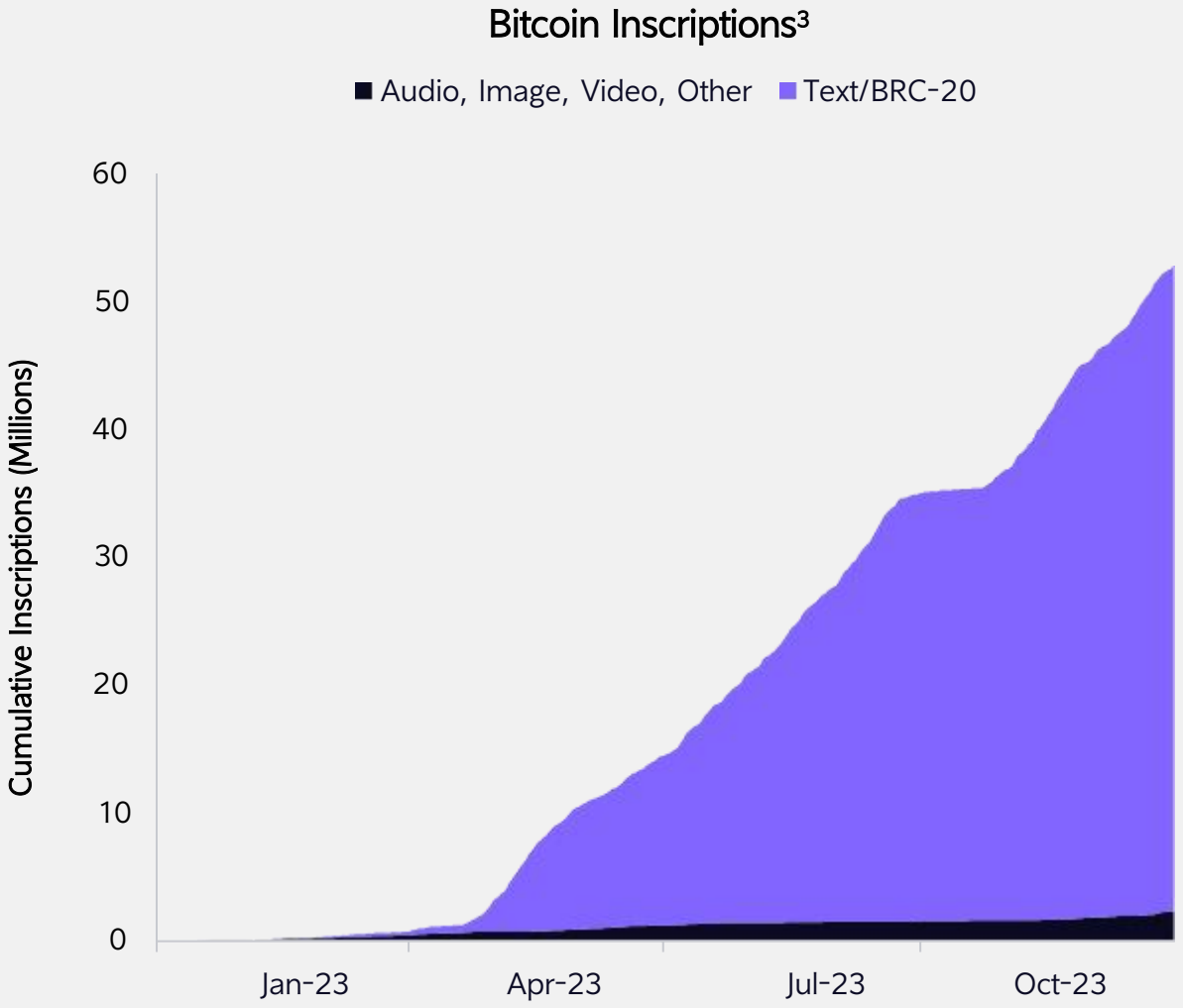
Sources: ARK Investment Management LLC, 2024, based on data from Bloomberg and Glassnode as of December 31, 2023. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

铭文的激增标志着比特币网络在交易结算之外的作用

比特币铭文于2023年1月推出，根据其在区块链中的位置，为每个比特币的最小单位satoshi引入了一个独特的编号系统。每个satoshi都是可识别和不可变的，允许用户记录他们的数据，图像或文本。

与其他需要NFTs1智能合约的区块链不同，比特币铭文位于比特币区块链的基础层。

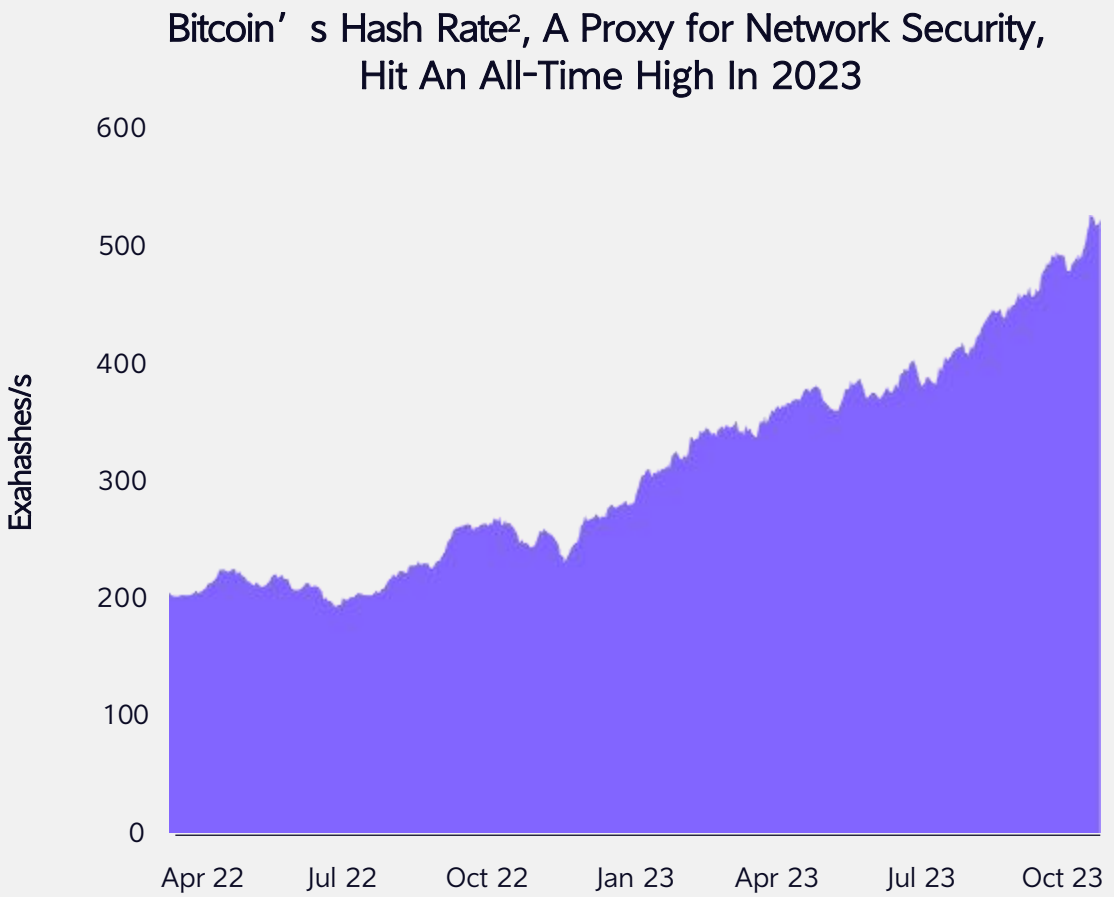
Ordinals2引发了关于铭文对交易规模和区块空间的影响的争论。在我们看来，普通货币是自由市场的产物，代表着比特币的健康创新。



[1] Short for Non-Fungible Token, it is tokenized metadata via unique identification codes recorded on a blockchain. [2] Refers to the creation of non-fungible tokens (NFTs) in the Bitcoin network by making Inscriptions, where metadata such as images or videos are attached to individual satoshis (the smallest unit of account). [3] BRC-20: A token standard that enables the minting and transaction of fungible tokens via the Ordinals protocol on the Bitcoin network. Sources: ARK Investment Management LLC, 2024, based on data from Glassnode as of December 31, 2023. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

比特币的基本面在2022年危机期间没有跳过节拍，并在2023年继续快速发展

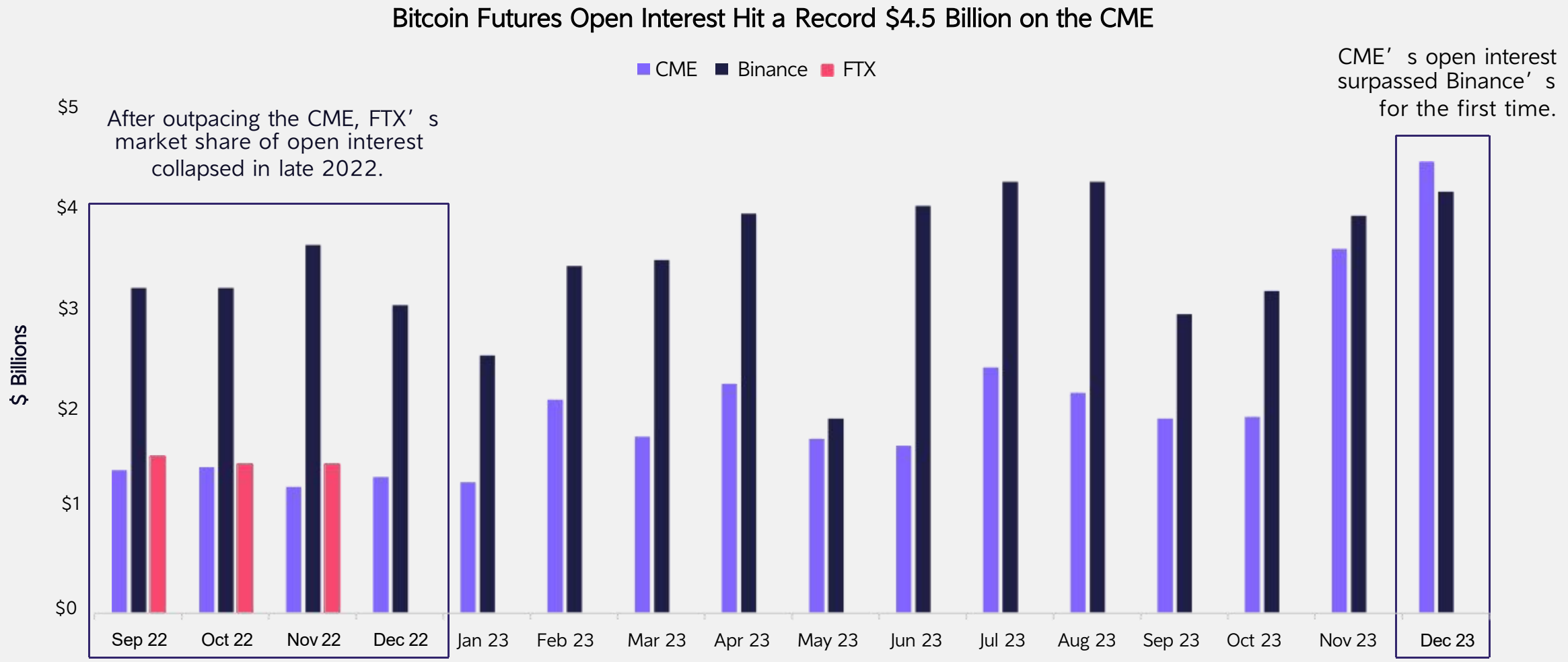
Bitcoin Network Stats	2022	2023
Price	$16,553	**$42,225**
Market Cost Basis[1] ($ Billions)[1]	$380.7	**$427.7**
Hash Rate[2] (EH/s[3], 14-Day Average)	254.3	**523.2**
Supply Of BTC Last Moved >1 Year Ago (%)	66.5%	**70.2%**
BTC Addresses With Non-Zero Balance[3] (Millions)	43.3	**51.7**
Long-Term Holder Supply[4] (BTC, Millions)	14.1	**14.8**
Transaction Count[5] (Non-Inscriptions Related, Thousands)	256.2	**367.5**



[1] The on-chain volume-weighted average price of the market, calculated by aggregating the value of all bitcoins in circulation at the time when they last moved. Also known as realized price or realized cap. [2] The estimated computational power mining within and providing security to the Bitcoin network. [3] Number of addresses in the Bitcoin network with a balance larger that zero. [4] Bitcoin supply last moved 155 days ago or more, the threshold at which the possibility of a bitcoin remaining unmoved increases drastically. [5] Number of transactions between two addresses of the Bitcoin network. Sources: ARK Investment Management LLC, 2024, based on data from Glassnode as of December 31, 2023. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

CME * 超过Binance成为全球最大的比特币期货交易所

随着2022年疫情蔓延后对更受监管和安全的基础设施的需求增加，比特币的市场动态更多地转移到美国。



*Short for Chicago Mercantile Exchange. Sources: ARK Investment Management LLC, 2024, based on data from Glassnode as of December 31, 2023. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

比特币正在演变成一种可靠的风险资产

随着宏观经济不确定性的增加和对传统 “安全飞行” 的不信任，比特币已成为一种可行的替代方案。

比特币作为风险资产的评估

安全性和资本保全	多样化	长期投资期限	流动性	通胀对冲
比特币在分散的网络上运行，独立于任何单一实体，政府或中央银行。它的分布式开源特性可以防止任意资产扣押和交易对手风险。	比特币与传统资产类别的历史低相关性正在增加其作为多元化来源的作用。在投资组合中增加一种不相关的资产可能会增加每单位风险的回报，并为市场低迷提供缓冲。	尽管比特币存在短期波动，但它已经带来了显著的长期价格升值。通过设计，稀缺性增加了资本保全的可能性。	全球投资者可以全天候访问和交易比特币，这在风险规避不确定性时期变得越来越重要。	比特币的供应量将限制在2100万个硬币。与黄金一样，稀缺性使比特币成为避险资产。

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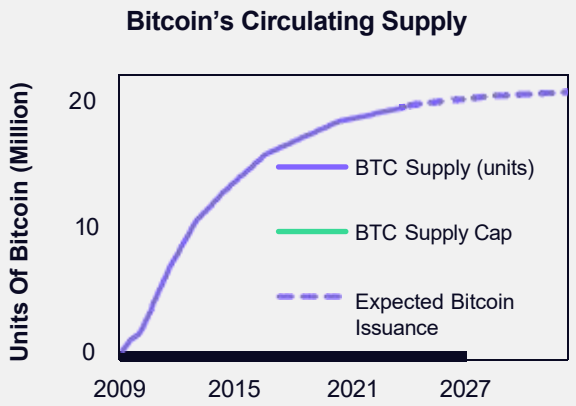
2024年比特币等待的催化剂

比特币现货ETF推出

2024年1月11日，现货比特币etf的推出为比特币的增长奠定了基础，为投资者提供了一种更直接、更规范、更流动的方式来获得风险敞口。比特币现货etf在主要证券交易所交易，允许投资者通过其现有的经纪账户买卖股票，并应减少与比特币直接投资相关的学习曲线和操作复杂性。

比特币减半

比特币减半大约每4年发生一次，将挖掘新比特币块的奖励减少了一半。从历史上看，每一次减半事件都与牛市的开始相吻合。预计在2024年4月，这一减半将使比特币的通胀率从1.8%降低到0.9%。



机构接受度

由于其持续的弹性和表现，对比特币的看法的转变-从投机工具到多元化投资组合的战略投资-应该成为2024年其演变的特征。为了证明这一演变，贝莱德首席执行官拉里·芬克 (Larry Fink) 已经将他的立场从对比特币的怀疑转变为 “向质量飞行” 的潜力。"

监管发展

FTX和Celsius的破产推动了对更加透明和开放的全球加密监管的推动，包括可能通过一项建立加密货币监管框架的美国法案。以及欧洲加密资产市场 (MiCA) 法规的实施，该法规要求欧盟的加密钱包提供商和交易所获得许可。

Sources: ARK Investment Management LLC, 2024, based on data from Glassnode as of December 31, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Research By: **Frank Downing**
Director of Research,
Next Generation
Internet

智能合约

为互联网原生金融体系提供动力

Sources: ARK Investment Management LLC, 2024. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

智能合约部署在公有区块链上，为寻租中介机构和传统金融基础设施提供了一种全球性、自动化和可审计的替代方案。

在2022年的 “加密货币危机” 之后，一些数字资产解决方案获得了关注，包括稳定币，代币化的国库基金和扩展技术。

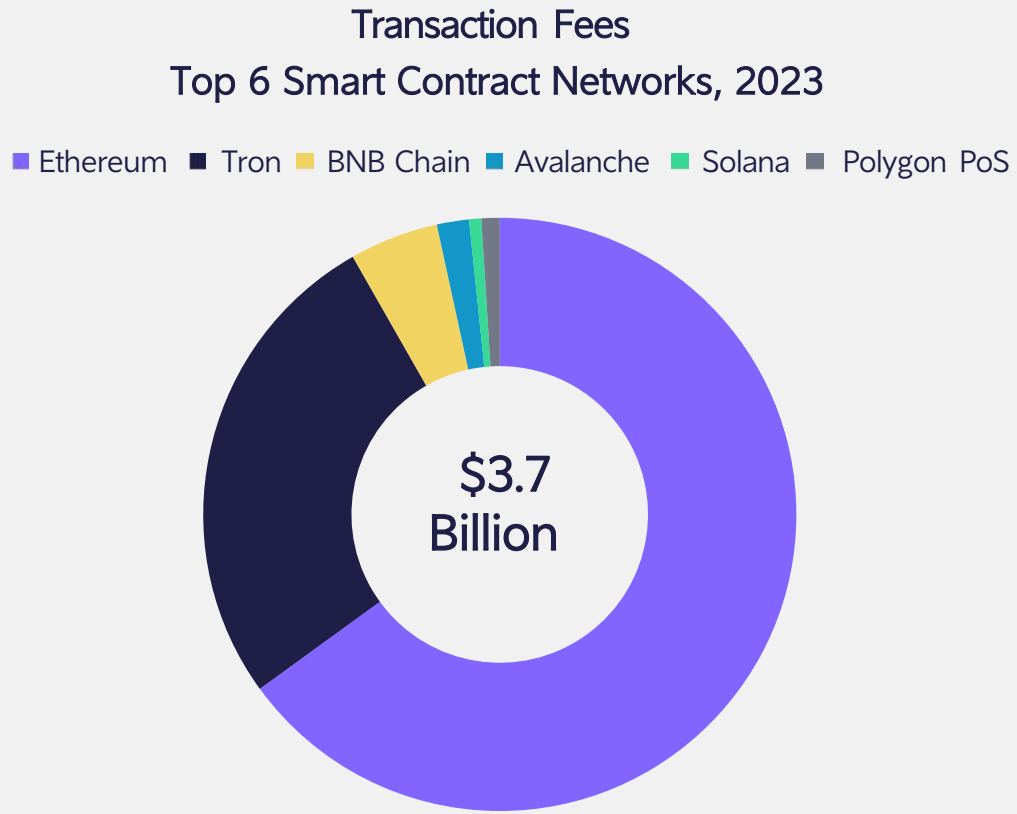
根据ARK的研究，随着链上金融资产价值的增加，与去中心化应用相关的市场价值可能以每年32%的速度增长，从2023年的7750亿美元到2030年5.2万亿。

Public blockchains are digital asset ledgers openly available for participants to access and are not controlled by a single entity. Smart Contracts are programs that exist on a blockchain and execute computer code when specific conditions are met. Sources for stablecoin usage, treasury issuance, and core development are provided in the corresponding slides that follow. Sources: ARK Investment Management LLC, 2024, based on a range of external sources, which are available upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

智能合约是互联网金融体系的基础

在起步阶段，智能合约正在为互联网原生的新金融系统提供动力。在最大的智能合约区块链以太坊的点燃下，多个网络正在支持链上活动并争夺市场份额。

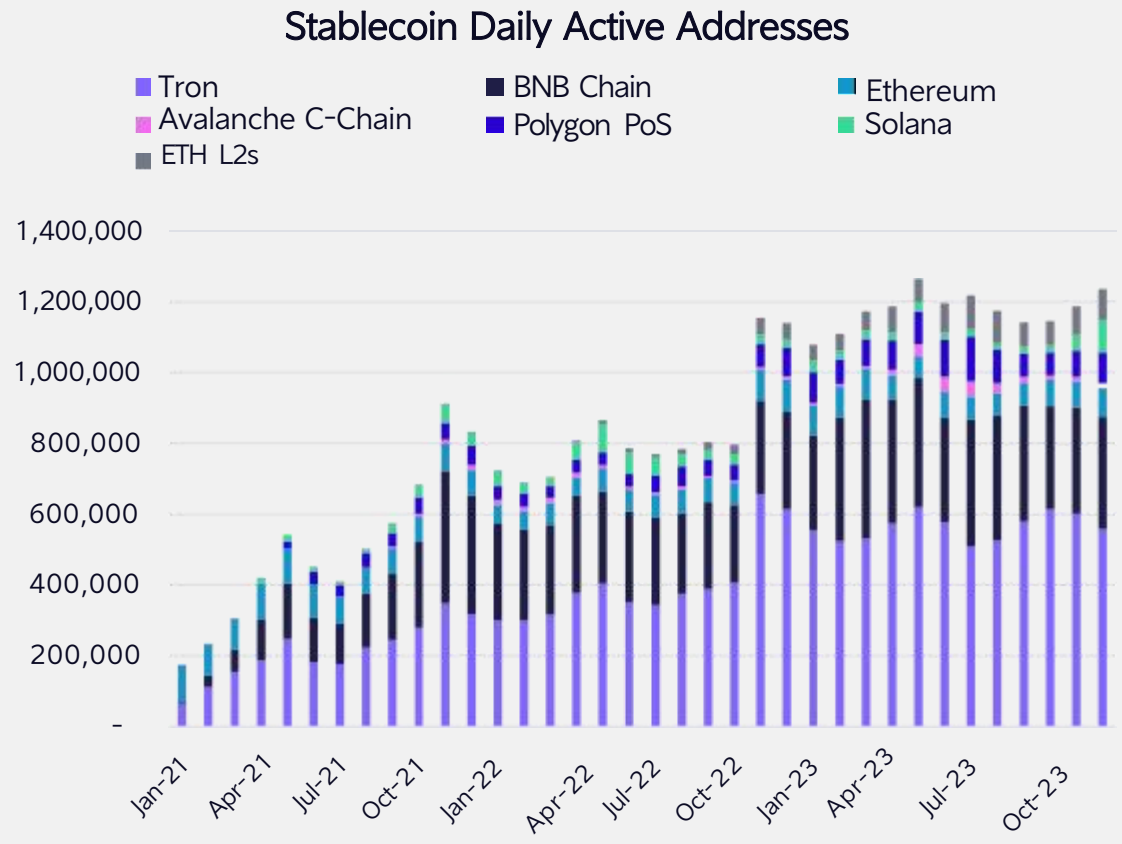
Smart Contract Network	Market Value 2023e	Price Performance 2023
Ethereum	$ 274 billion	+90%
BNB Chain	$ 49 billion	+28%
Solana	$ 44 billion	+924%
Avalanche	$ 14 billion	+254%
Tron	$ 9 billion	+120%
Polygon PoS	$ 9 billion	+28%



NOTE: Networks represented are smart contract Layer 1 blockchains with >$10 million in 2023 transaction fees. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which are available upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

稳定币突出了智能合约的价值主张

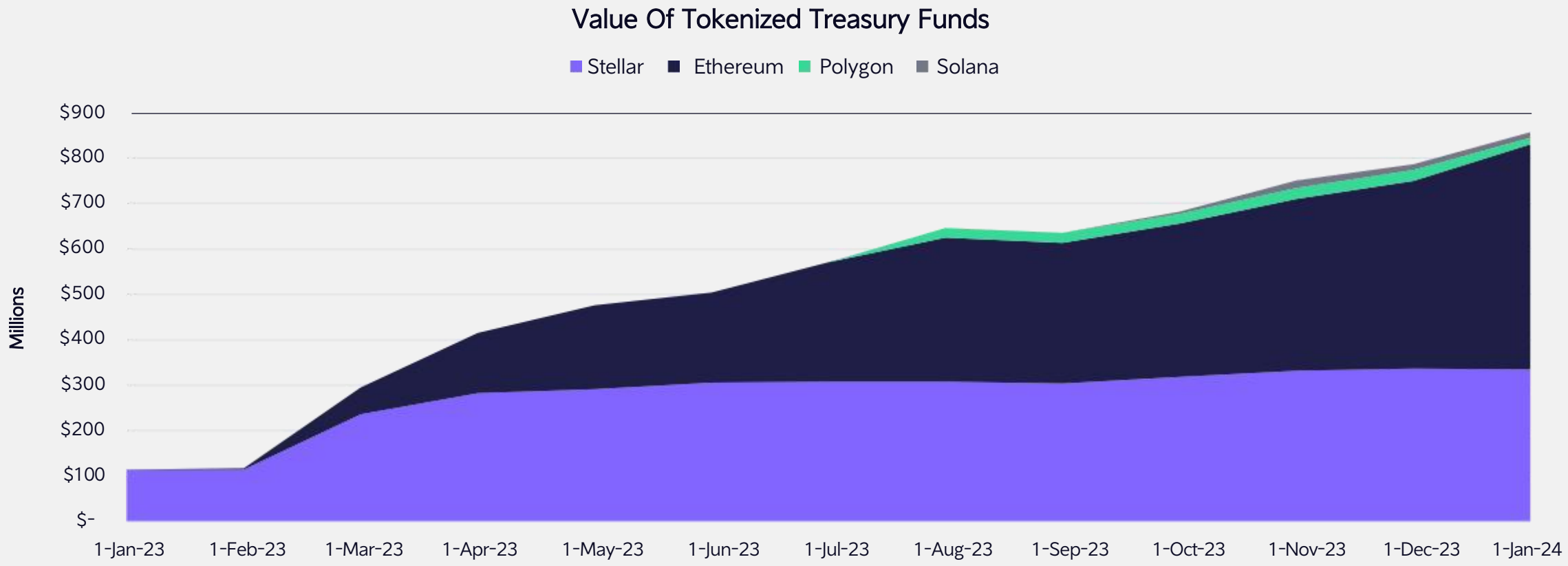
鉴于新兴市场的恶性通货膨胀和全球不稳定的加剧，对提供美元数字访问的稳定币的需求正在飙升。在过去三年中，全球每日活跃的稳定币地址数量以每年93%的速度增长，从17.1万个增加到120万。2023年，稳定币的转让量超过了万事达卡。



NOTE: Stablecoin Daily Active Addresses are averaged for each month displayed in chart. Transfer volume estimates are used where Q4 2023 data is not yet available at time of publication. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which are available upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

传统金融资产正在转向链上合约

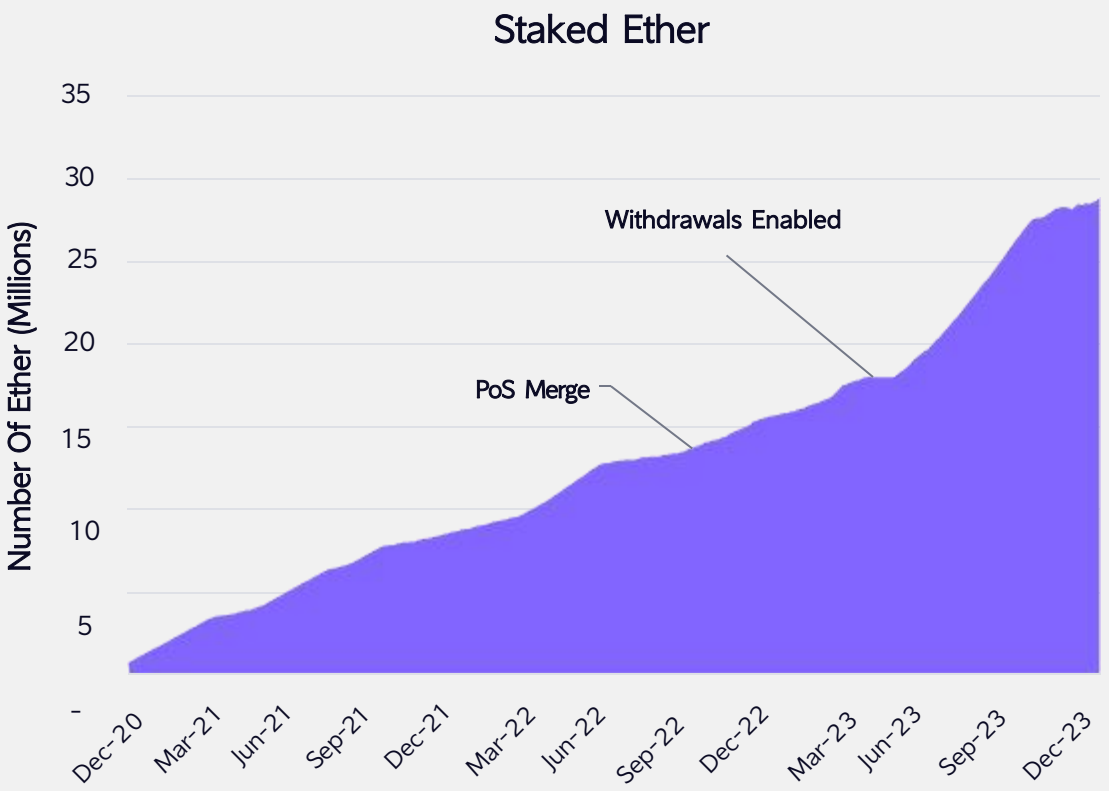
与传统金融市场相比，令牌化允许财务主管在公有区块链上更容易地跟踪、交易和抵押资金。2023年，代币化的美国国债基金增长了7倍多，达到8.5亿美元。早期基金在恒星区块链上推出，但以太坊在2023年成为代币化国债的最大市场。

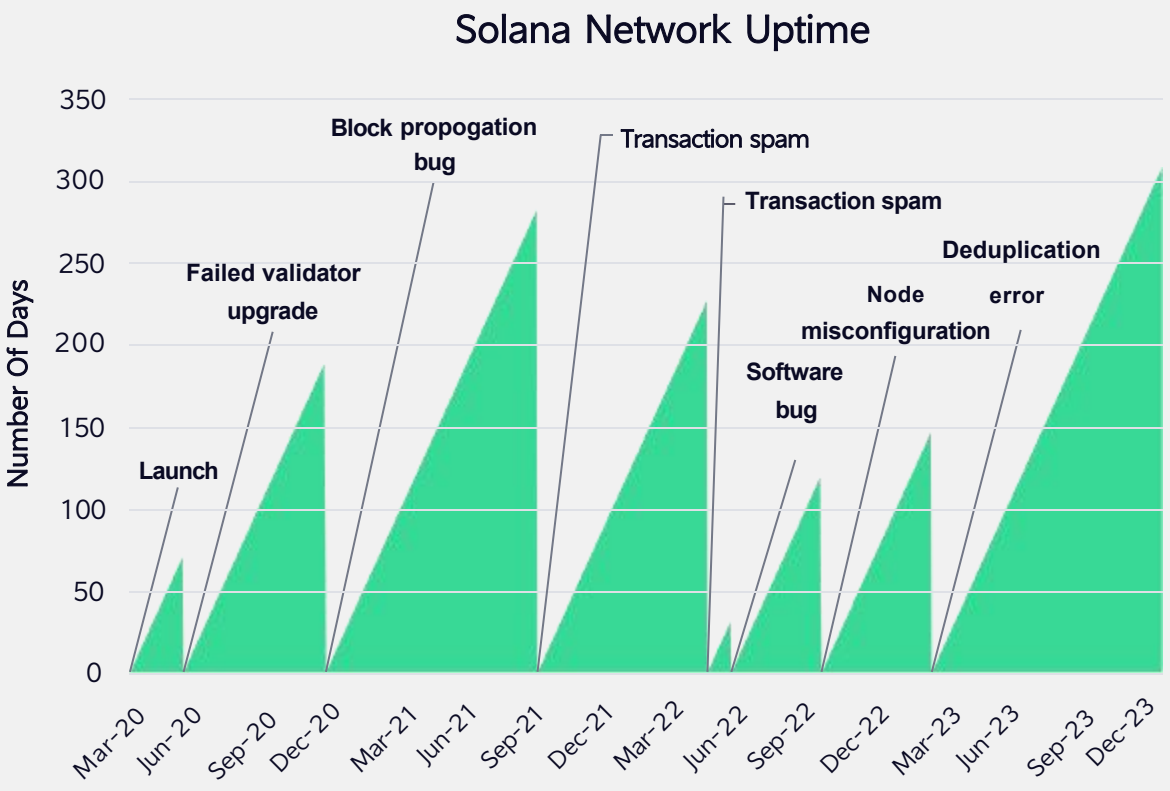


Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which are available upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

开发人员在熊市期间完善了协议

面对2022年的危机及其后果，核心开发人员提出了先进的技术路线图和强化的协议，以支持下一轮牛市。以太坊成功达成了权益证明 (PoS)* 共识，Solana创下了连续正常运行时间的新纪录。

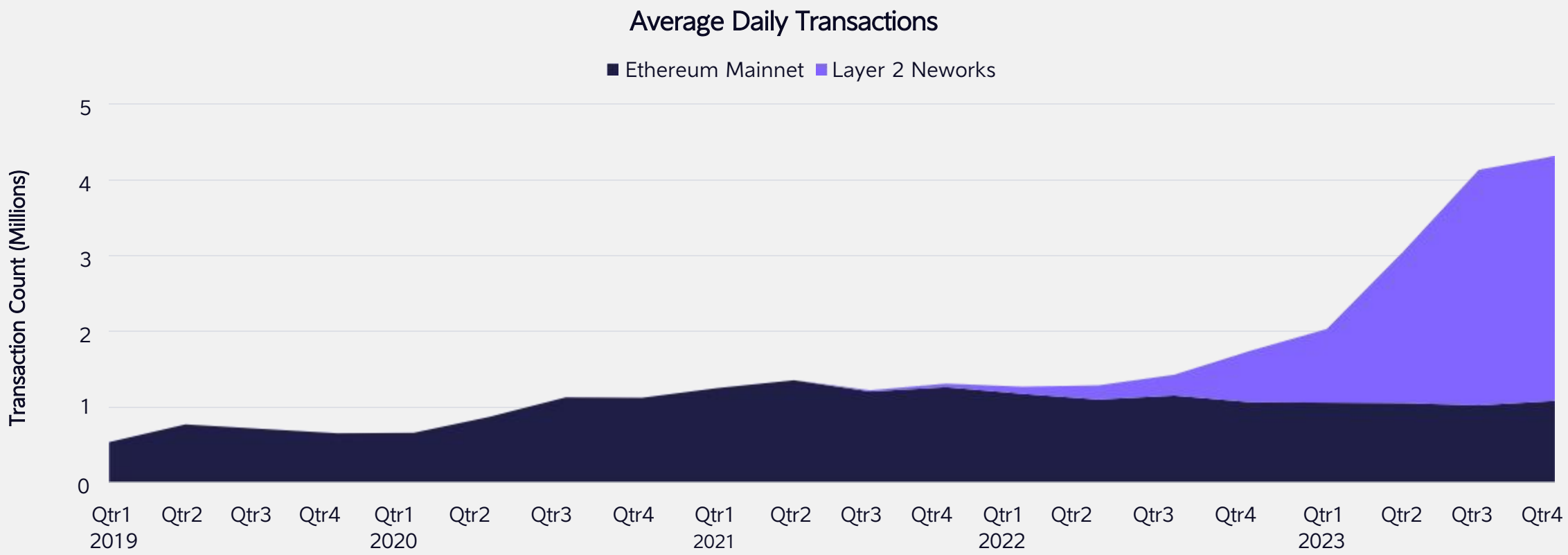




*Proof-of-Stake is a method of securing public blockchains, in which network participants who wish to validate transactions on the network pledge or "stake" their assets at risk of loss if they fail to operate within the network's rules. Chart data end 12/31/23. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which are available upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

第2层网络在以太坊生态系统中扩展了交易

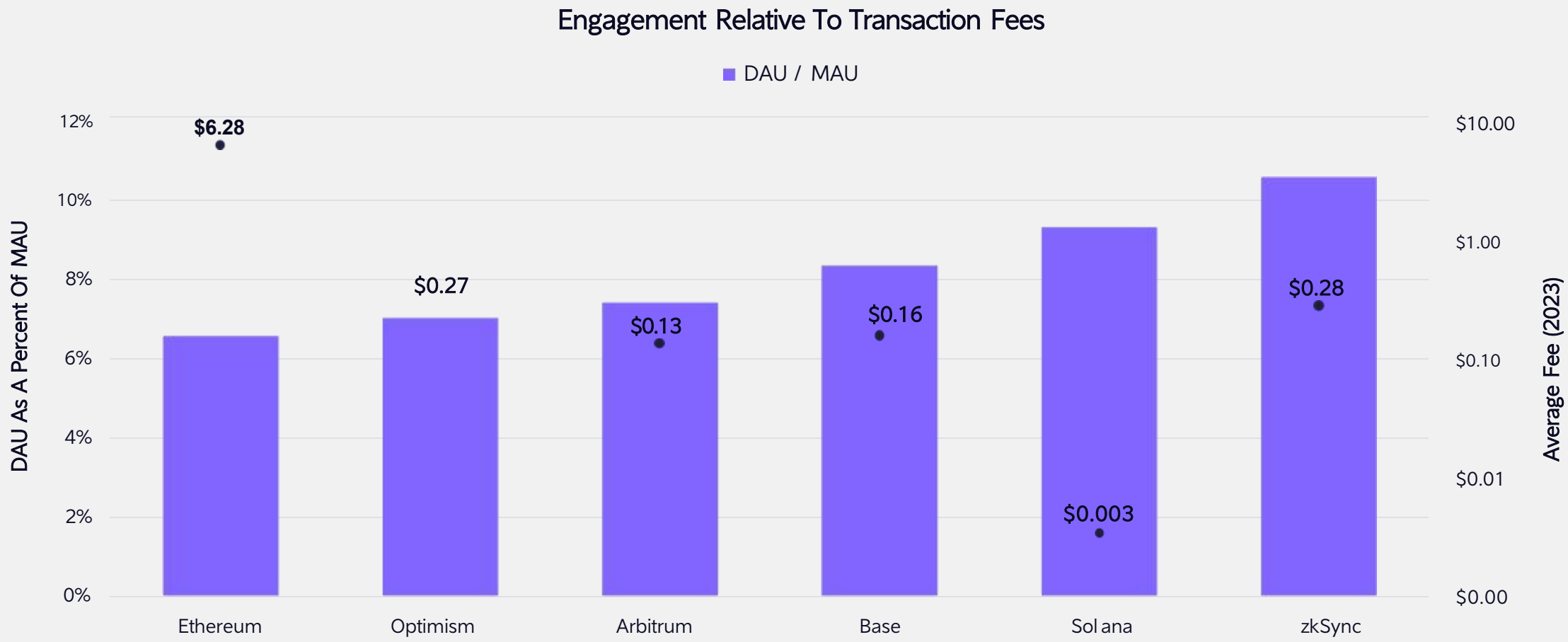
自2021年初以来，已经20多个第2层 (L2)* 网络推出，使以太坊能够以更低的费用将平均每日交易规模扩大4倍。尽管早期取得了成功，但大多数L2网络都是集中控制的。L2s的激增具有复杂的用户和开发者体验。



*L2 networks aggregate transactions and settle the resulting state changes to a base-layer smart contract network like Ethereum, typically at higher throughput and lower cost compared to the base network. L2 transaction count is based on data available on Artemis Dashboard: Arbitrum, Base, Linea, Optimism, Polygon zkEVM, Scroll, StarkNet, zkSync Era, Zora Network. Chart data end 12/31/23. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which are available upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

较低的成本促进链上合约参与度提升

随着交易成本的下降，以每日活动地址 (dau) 与每月活动地址 (mau) 的比率衡量的链上合约参与度有所增加。

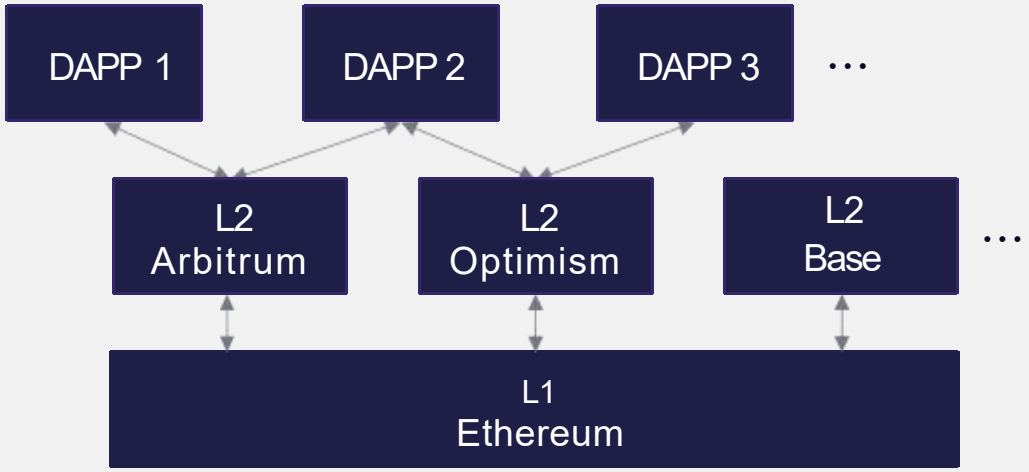


Note: DAU / MAU traditionally refers to a measure of unique users. For this analysis, we are using a measure of unique addresses as an approximation for users. They are correlated but not equivalent. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which are available upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

像Solana这样的单片链提供了垂直缩放的替代方案

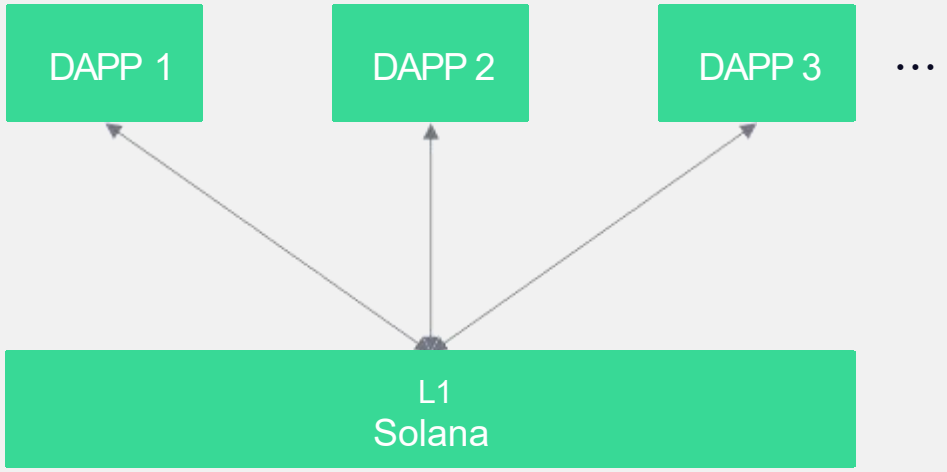
智能合约网络设计提供了权衡。通过优先考虑基础层去中心化，以太坊生态系统在扩展时变得更加复杂。通过在单个层中优先考虑可扩展性，Solana为用户和应用程序开发人员维护了一个简单的架构，并获得了牵引力。

Vertical Scaling



+ 最大限度地降低L1验证成本	- 需要L1和L2之间的资产桥接，分散流动性
+ 支持多种扩展方法，鼓励灵活性和创新	- 增加了开发人员和用户的复杂性
+ 利用以太坊主网络的网络效应和流动性优势	- 跨L2s引入额外的可靠性和安全性注意事项

Horizontal Scaling



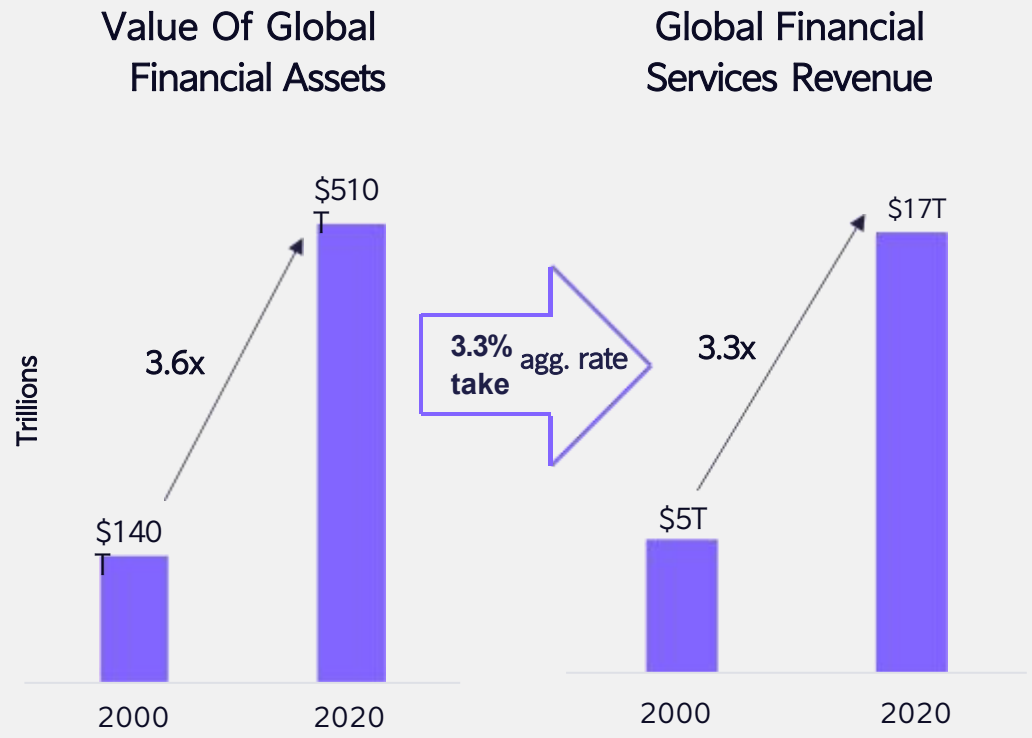
+ 为开发人员和用户简化环境	- 提高L1验证成本
+ 最大限度地提高可组合性和互操作性	- 可能需要L2s最大限度地扩展
+ 降低基本层事务的费用并提高吞吐量	- 需要应用程序依赖于L1执行环境

Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which are available upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

智能合约可能带来金融服务的成本骤降

全球金融资产的价值从2000年的140万亿美元膨胀到2020年的510万亿美元，这得益于全球经济增长，金融化程度提高和股本倍数的扩大。全球金融体系的运营成本随着金融资产的价值而增加。

在20万亿美元的年总收入中，金融服务业的总收入率为3.3%，相对于所有金融资产的价值。智能合约可以大大降低对经济的拖累。



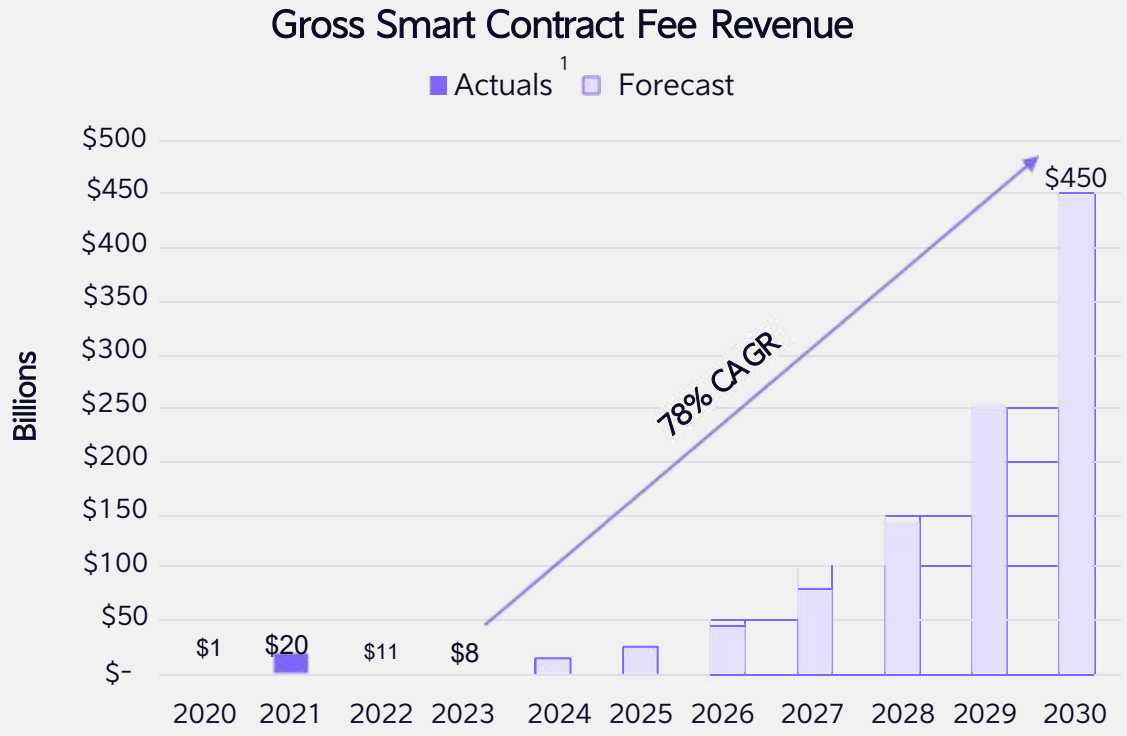
金融监管合规性的经济影响

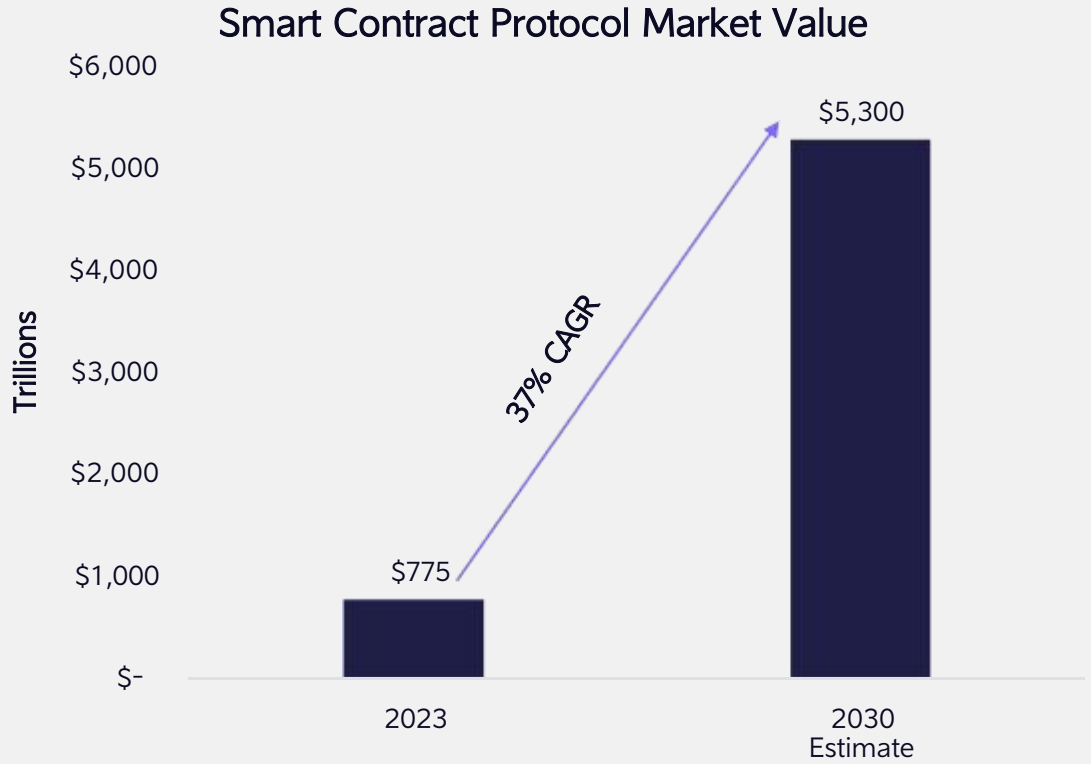
活动	当前系统的成本	降低成本的解决方案
客户验证	每次验证1500到3000美元	跨机构可验证的统一数字身份
纳斯达克上市费	每家上市270,000美元 + 52,000-180,000美元年费	全球分销的直接DEX上市
全球反洗钱合规	全球金融体系每年损失2740亿美元	全球分类账中资金的可审计来源

Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which are available upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

智能合约网络在2030年可能产生4500亿美元的费用

智能合约可以促进链上资产的起源、所有权和管理，而这只是传统财务成本的一小部分。如果金融资产以类似于互联网采用的速度迁移到区块链基础设施，与去中心化金融服务相关的利率是传统金融服务的三分之一，智能合约可以产生超过4500亿美元的年费，创造超过5万亿美元的市场价值。到2030年，复合年增长率分别为78%和32%。





[1] 2020-2021 data approximated using top 20 all-time fee generating protocols from Token Terminal Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which are available upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Research By:
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Associate Portfolio Manager
Andrew Kim
Analyst

数字消费者

向数字休闲转型

本报告为ARK投资出品的年度研究报告，智能小巨人科技进行了编译，仅供学习参考，请勿用于商业用途

Sources: ARK Investment Management LLC, 2024. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

根据ARK的研究，数字休闲支出会从线下选择中获得份额，并在未来七年内以每年19% 的速度增长。从2023年的7万亿美元到2030年的23万亿美元。几个趋势正在加速向数字休闲的转变:

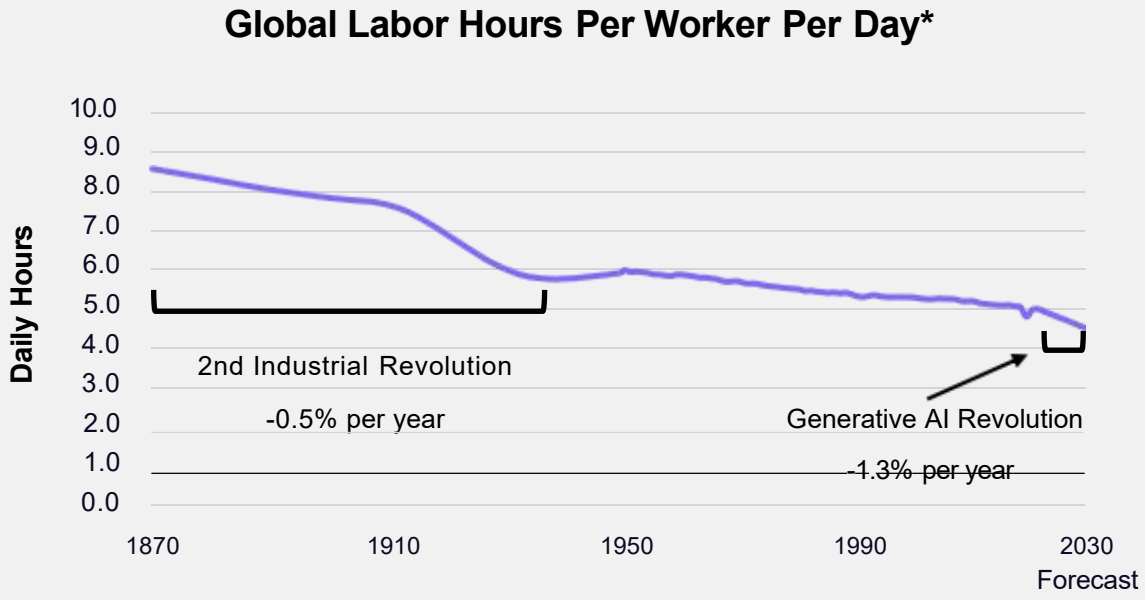
- **互联电视 (CTV) 广告**的复合年增长率为17%，从2023年的250亿美元增长到 2030年的730亿美元。
- **社交商业**以每年32%的速度增长，从今天的7300亿美元增长到2030年的5万亿美元。
- **体育博彩**保持涡轮增压的在线/移动博彩合法化。
- **人工智能辅助的视频游戏创作**是游戏的新浪潮，建立在Roblox等用户生成的平台上，该平台已经托管了全球超过4.7亿，52x于PC、游戏机和手机游戏的体验。
- **支持AI的硬件**可以重新定义个人可穿戴计算，特别是在虚拟现实 (VR) 继续面临挑战的情况下。

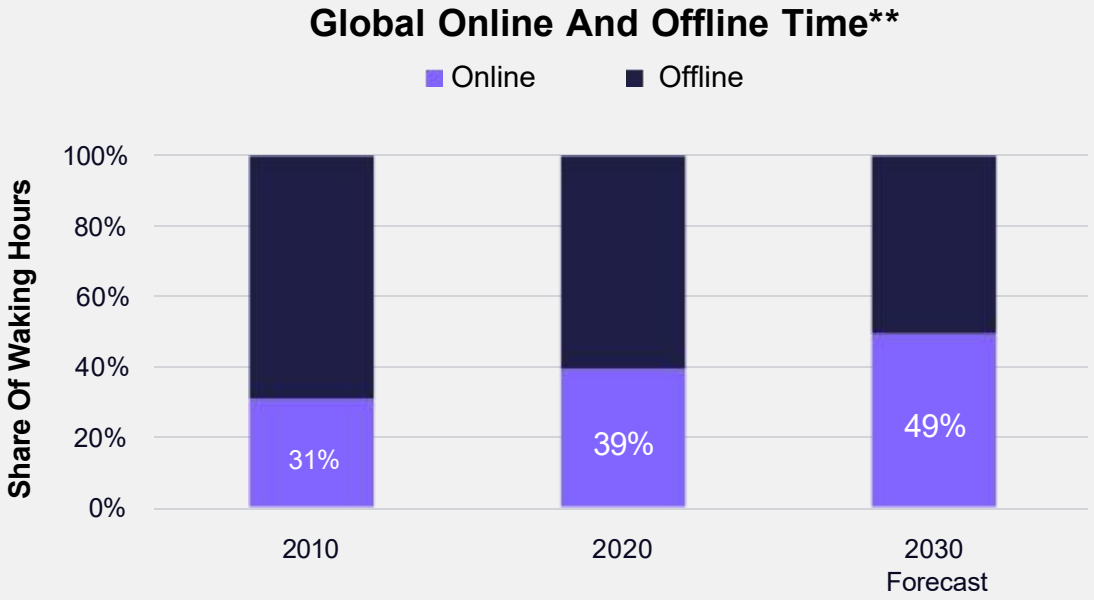
Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

人工智能可以降低平均每周工作时间并刺激数字消费

从第二次工业革命到第二次世界大战结束的80年间，全球每个工人的劳动时间每年减少0.5%。生成式人工智能可以将每个工人的平均劳动时间降低1.3%。从2022年每天5小时到2030年的4.5小时。

因此，消费者可能会将更多的时间投入到在线娱乐上，这可能会将在线总清醒时间的比例从2023年的40%增加到2030年的49%。

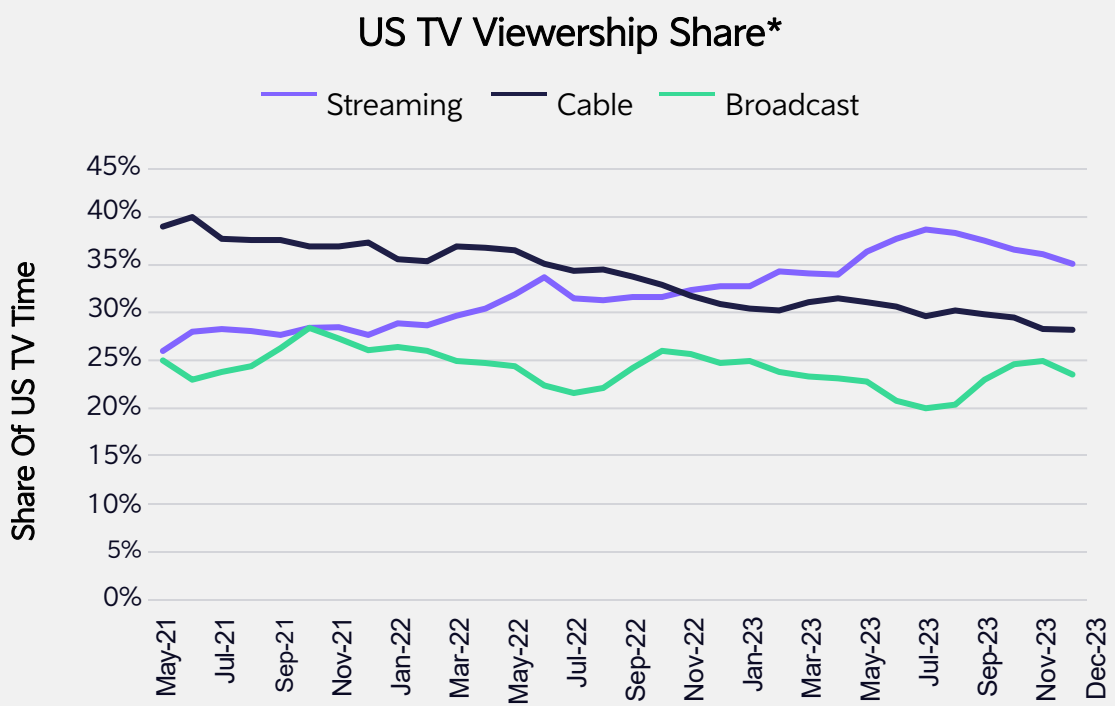


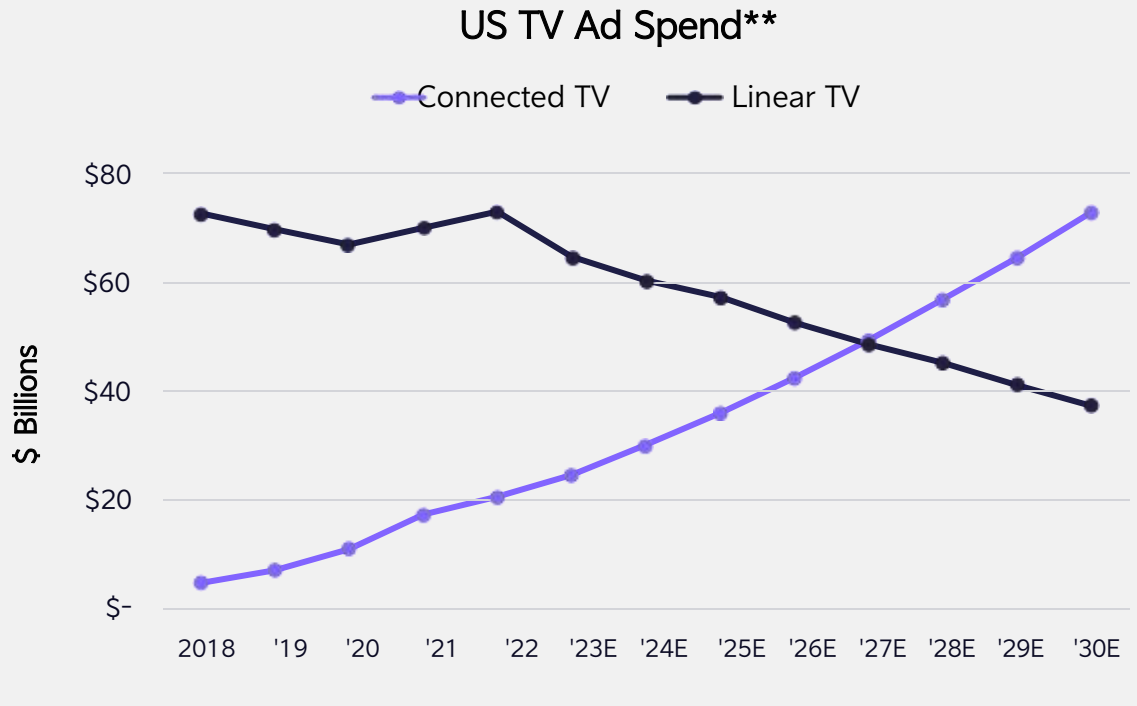


*To calculate global daily working hours, we divide total annual hours of labor per worker by the total days of the year. **The chart illustrating daily allocation of online vs. offline time captures total daily waking hours, including those allocated to labor or education. The chart captures hours generated by internet users only. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

流媒体电视正在取代有线电视

在短短两年内，截至2023年7月，流媒体在整体电视消费中的份额增长了10个百分点以上，达到39%，分别超过了有线电视和广播的份额。联网电视 (CTV) 的广告支出正在吸引眼球，按年率计算，可能会增长17%，从2023年的250亿美元增长到2030年的730亿美元。如果是这样的话，到2027年，CTV的广告支出应该会超过线性电视的广告支出。



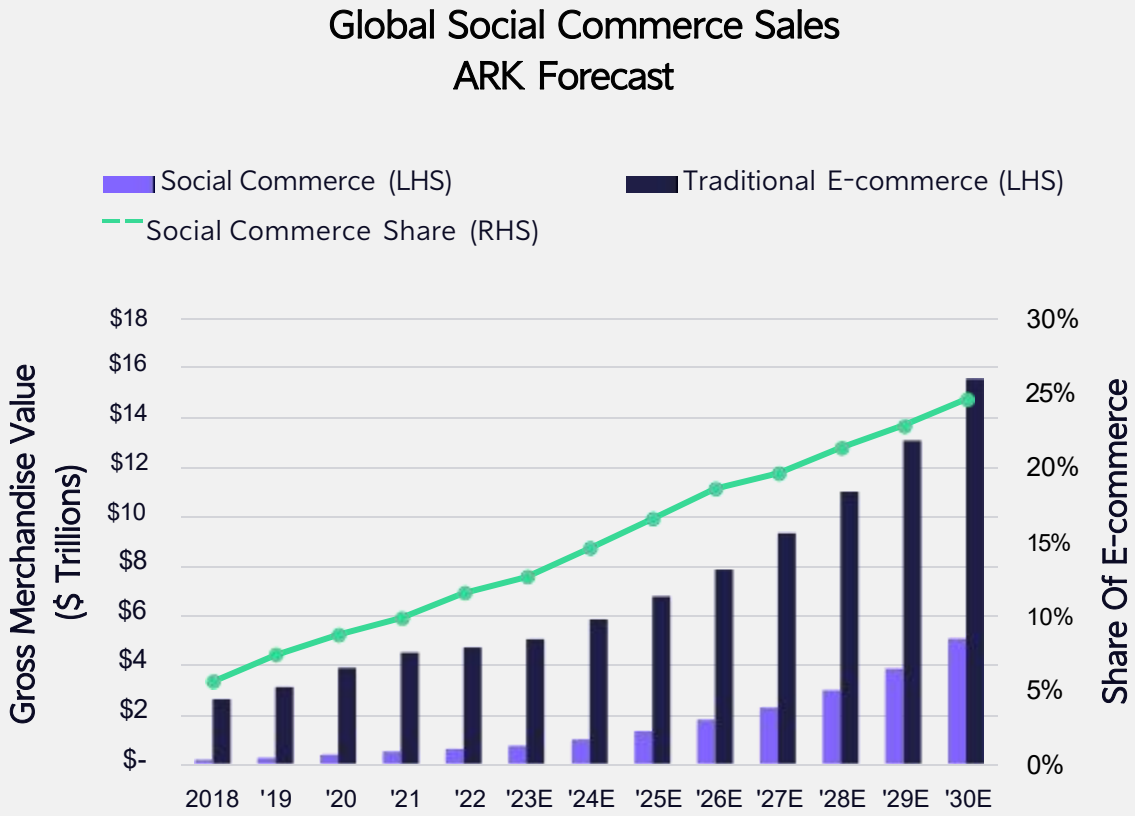


*The share of streaming, cable, and broadcast do not add up to 100%, as we exclude the portion of consumption that Nielsen categorizes as "Other," which includes time spent on unmeasured sources like video-on-demand (VOD), audio streaming, gaming, and other device use. **We define linear TV as traditional TV delivered via cable, satellite, or over-the-air. We define connected TV as streamed TV delivered over-the-top through smart TVs, streaming media devices, video game consoles, and other modern hardware. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including Nielsen, Insider Intelligence, and MAGNA Global, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

社交电商商家可以随时随地向任何人销售

社交媒体平台正在通过电子商务增加全球受众的货币化。归功了全渠道解决方案 (包括实体和数字)，社交商业可能会以每年32% 的速度增长，从今天的7300亿美元增长到2030年的5万亿美元以上。

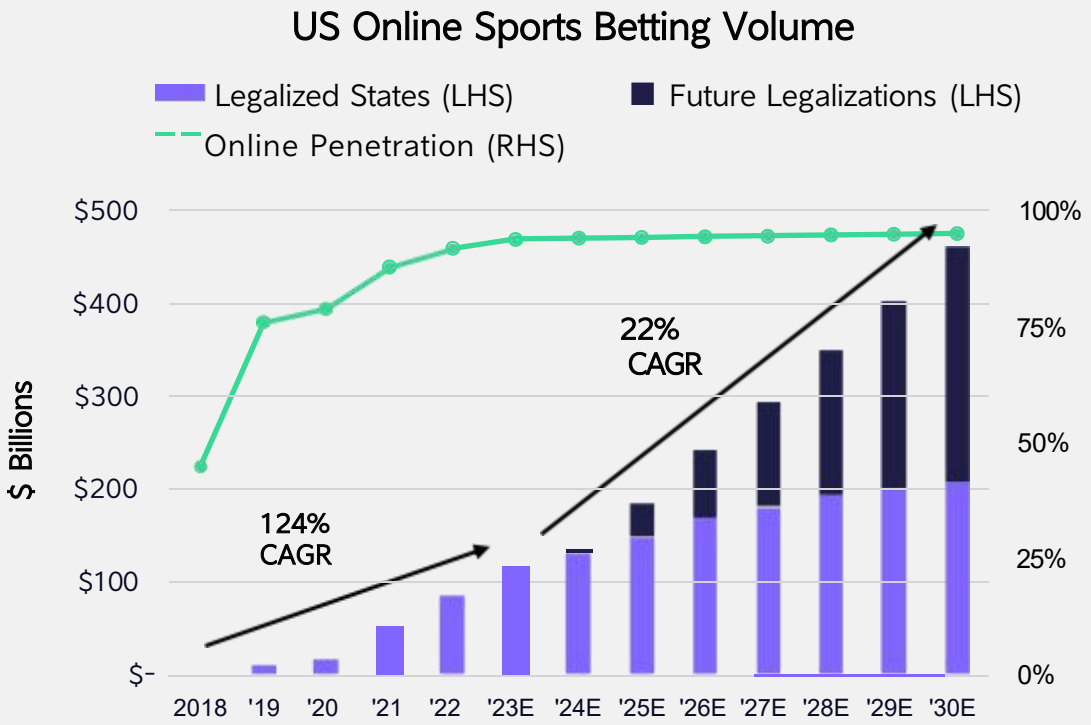
Business Launch – Omnichannel Selling – Payment Processing – Marketing
Analytics and Management – Logistics & Shipping – Business Funding

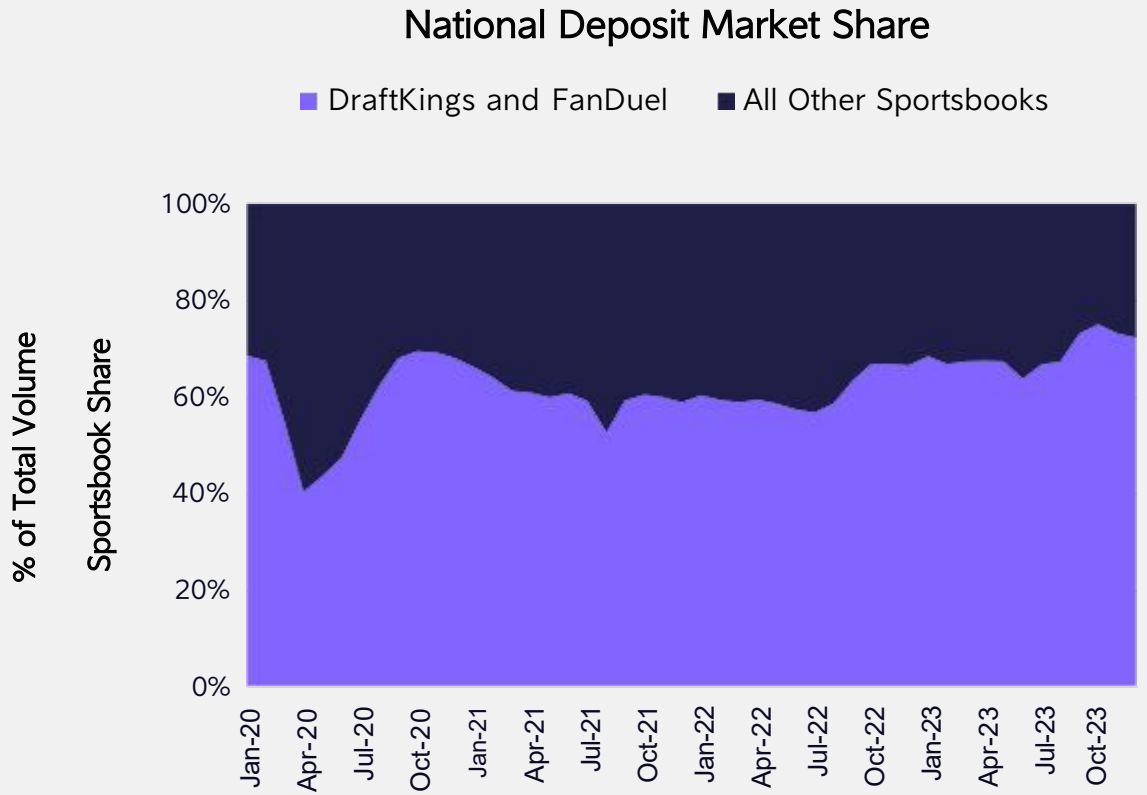


*We estimate each platform's monthly active users (MAUs) across its iOS and Android mobile apps. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including Sensor Tower, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

移动体育博彩在美国继续增长和巩固

由于合法化和消费者接纳，在线体育博彩的获胜者正在远离人群。随着在线体育博彩在2023年激增35%，DraftKings和FanDuel提供了卓越的用户体验，有助于从其他体育博彩中获得份额。DraftKings和FanDuel在2023年将其在国家存款中的份额增加到75%，而体育博彩的长尾则损失了8个百分点。

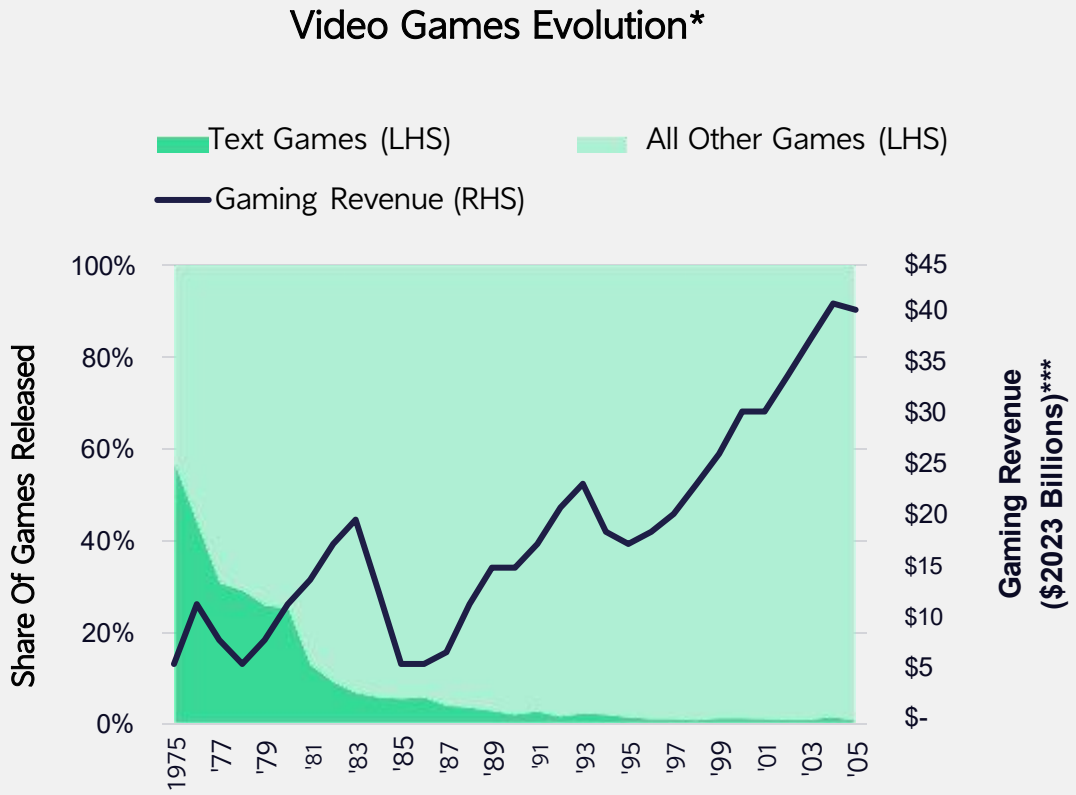


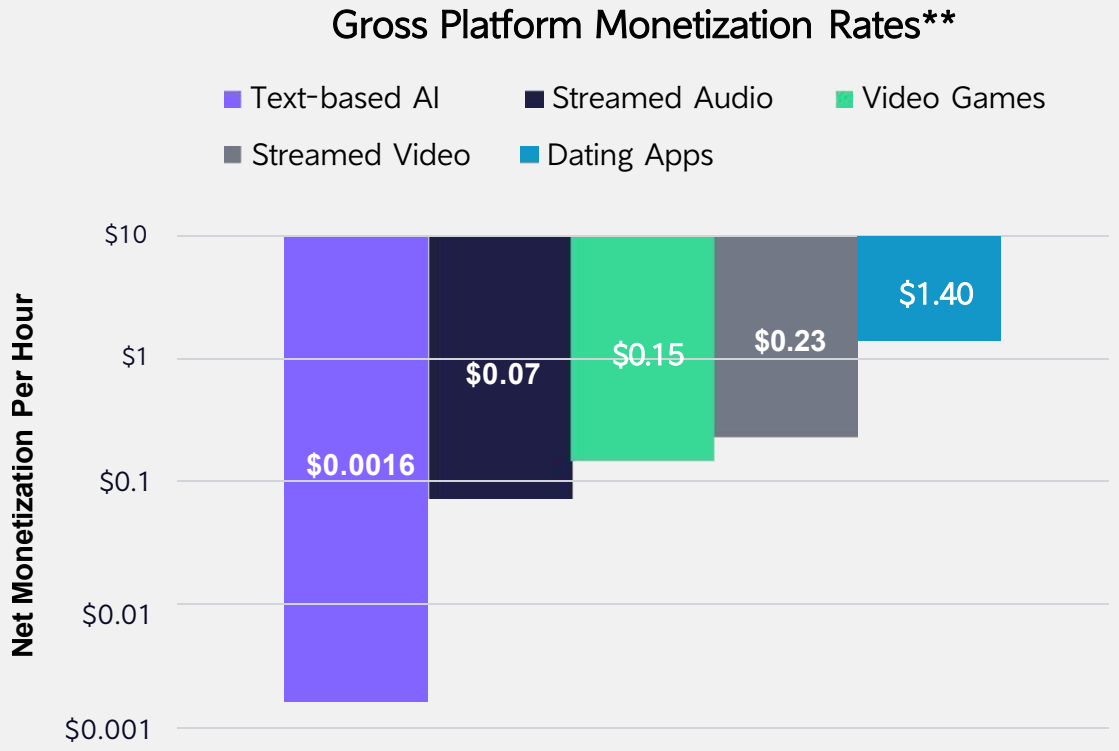


Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including Yipit Data, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

在线体验变得更加沉浸式和可货币化

历史表明，更深度的沉浸体验会导致更高的货币化。在1980年代，计算机图形学将市场扩展到基于文本的冒险游戏之外之后，游戏收入以每年19%的速度猛增，从1985年的60亿美元增长到1993年的240亿美元。现在，多模态人工智能 —— 文本、图像、音频和视频 —— 正在创造更加沉浸式的互动体验，这将扩大市场。



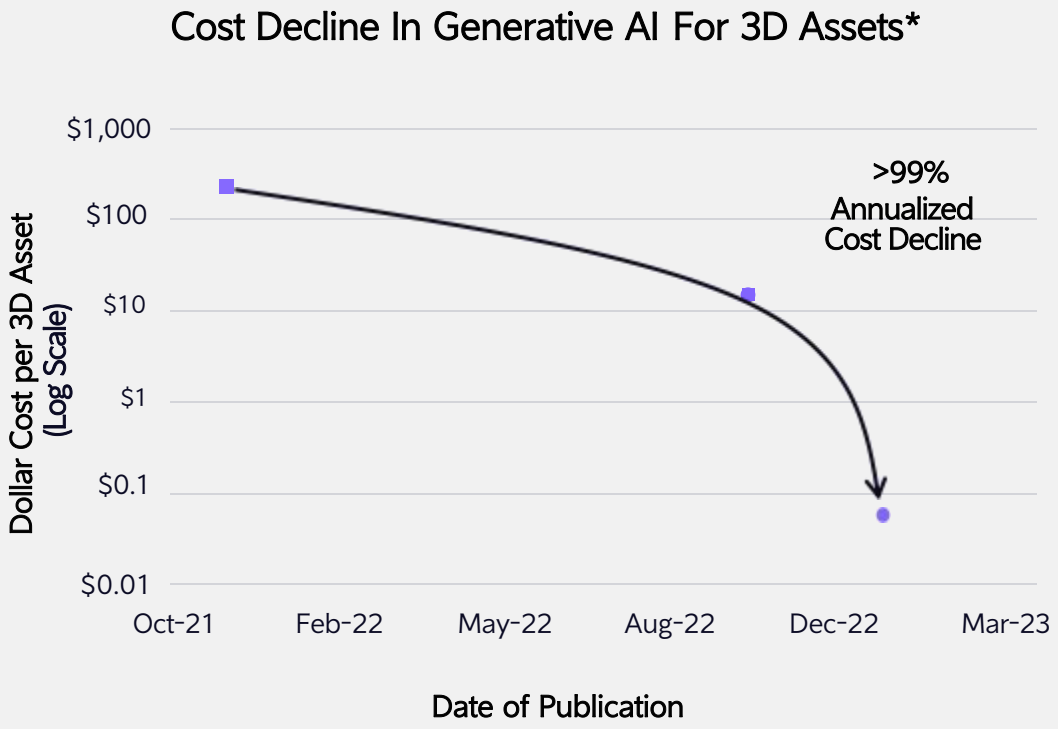


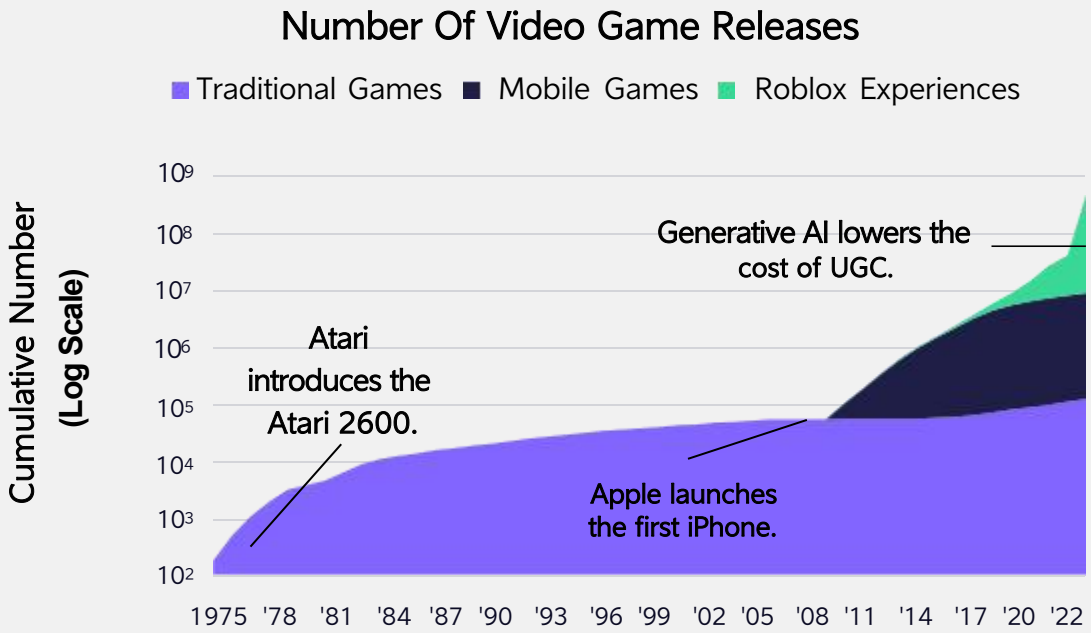
*" Text games" refer to both text-based and spreadsheet-based games. "All other games" exclude arcade game releases. Gaming revenue captures PC and console gaming revenue only **We estimate various platforms' ability to monetize on direct consumer spend only.. ***Revenue figures have been inflation-adjusted to 2023 US Dollars. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

由于AI辅助创作，游戏玩家可以成为开发者

在用户生成内容 (UGC) 平台上的AI辅助游戏创建可能会导致游戏内容激增。根据我们的研究，在对输出质量进行标准化之后，生成单个3D资产的成本对比2021年将以年化99%的速度下降，降至不到 $0.06美元。

人工智能会使内容创作民主化，并加速UGC的增长。Roblox已经在全球范围内提供了超过4.7亿的体验，是PC，游戏机和移动游戏总数的52倍。



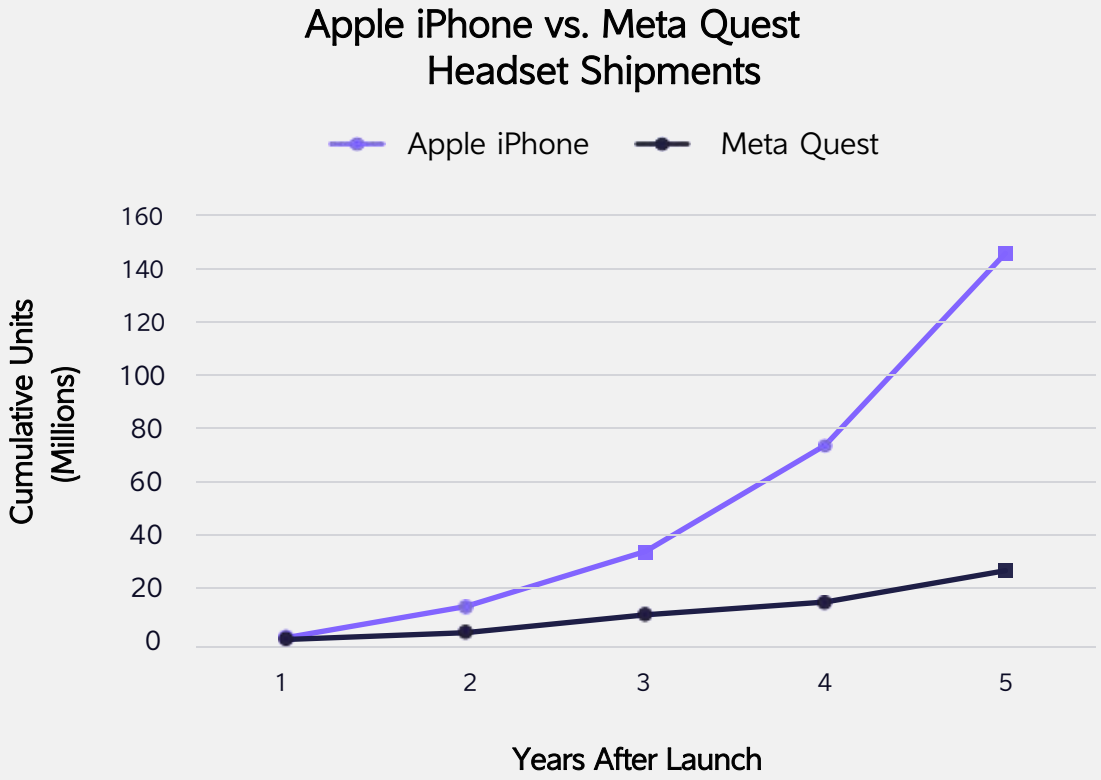


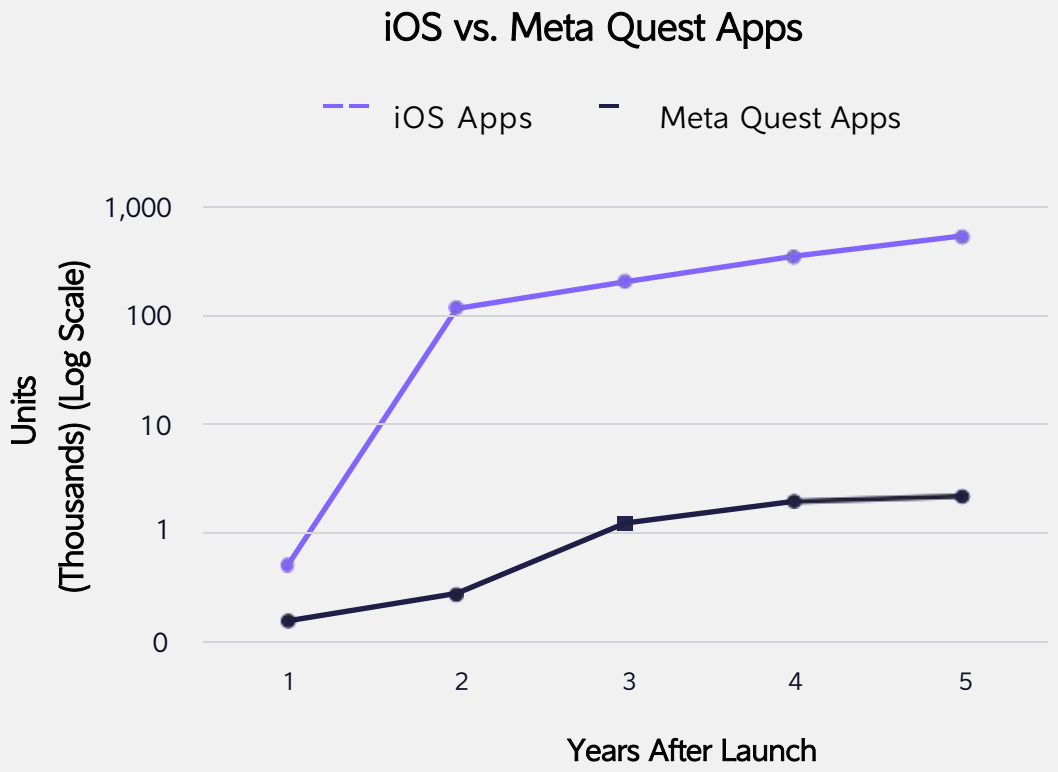
*We normalize the cost of 3D asset generation by each model's CLIP R-Precision scores. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including Nichol et al. 2022, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

虚拟现实市场刚刚起步

尽管包括苹果的Vision Pro在内的耳机有了重大改进，但开发人员并没有蜂拥而至支持虚拟现实 (VR)。没有引人注目的用例，采用一直很慢。

例如，Meta Quest仅提供2,200个应用程序 —— iPhone推出五年后吹嘘的553,000个应用程序的一小部分。因此，Meta仅售出了2700万部Quest头显，占苹果推出五年后累计售出的1.46亿部iphone的18%。



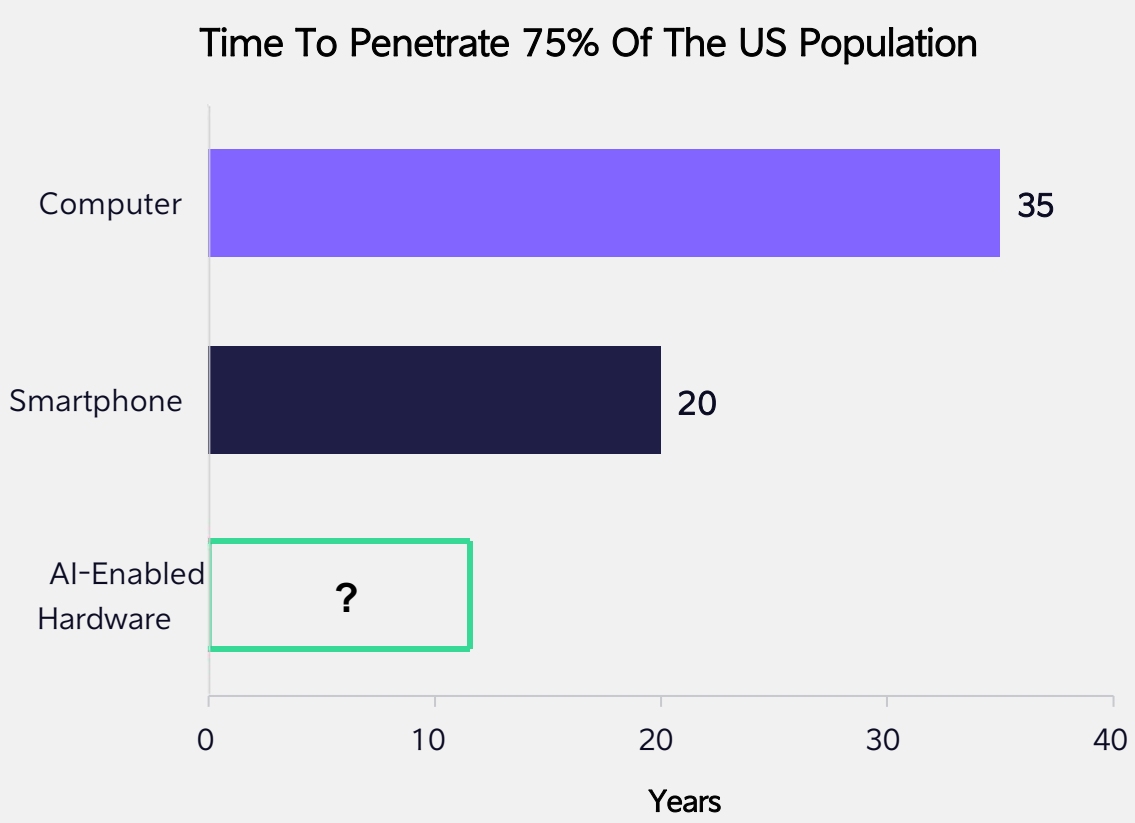


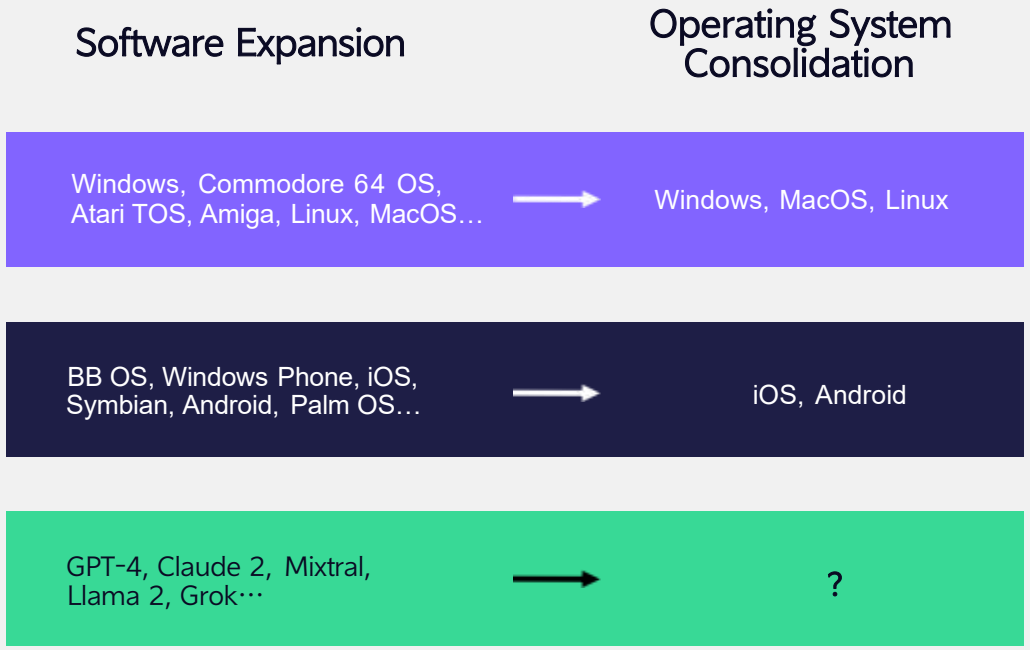
Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

AI可以重新定义个人计算

随着计算的过渡，硬件周期从个人计算机的35年压缩到智能手机的20年，导致软件玩家的整合。

更快地采用支持AI的硬件可以加速软件提供商的整合。



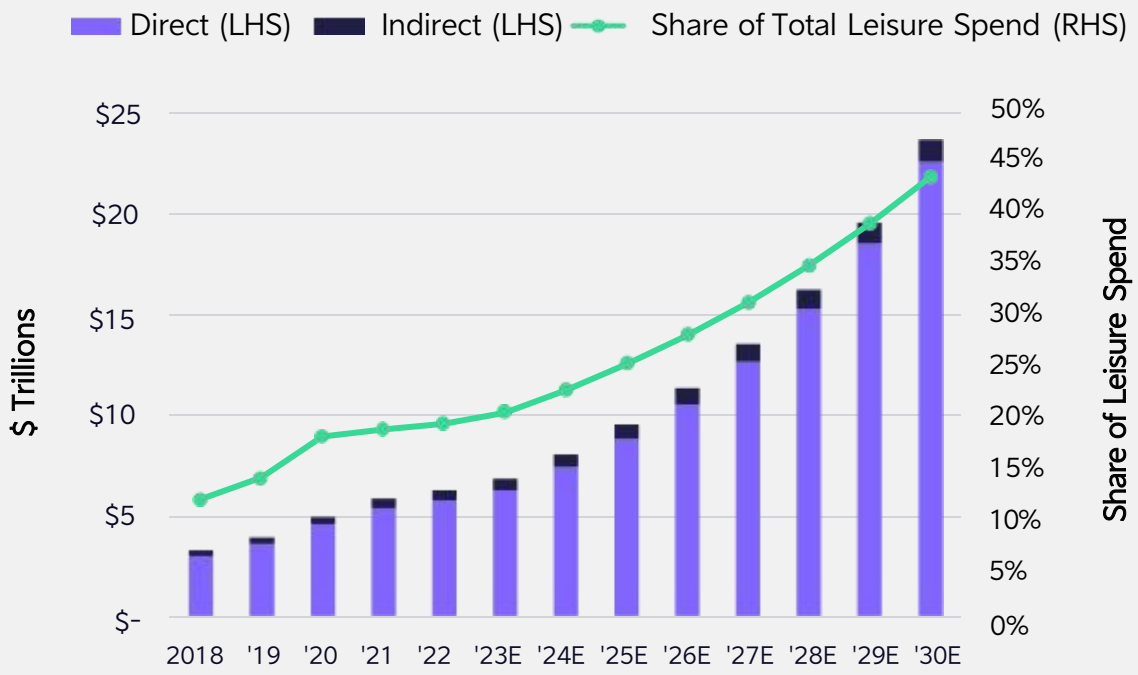


Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including DeGusta 2012, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

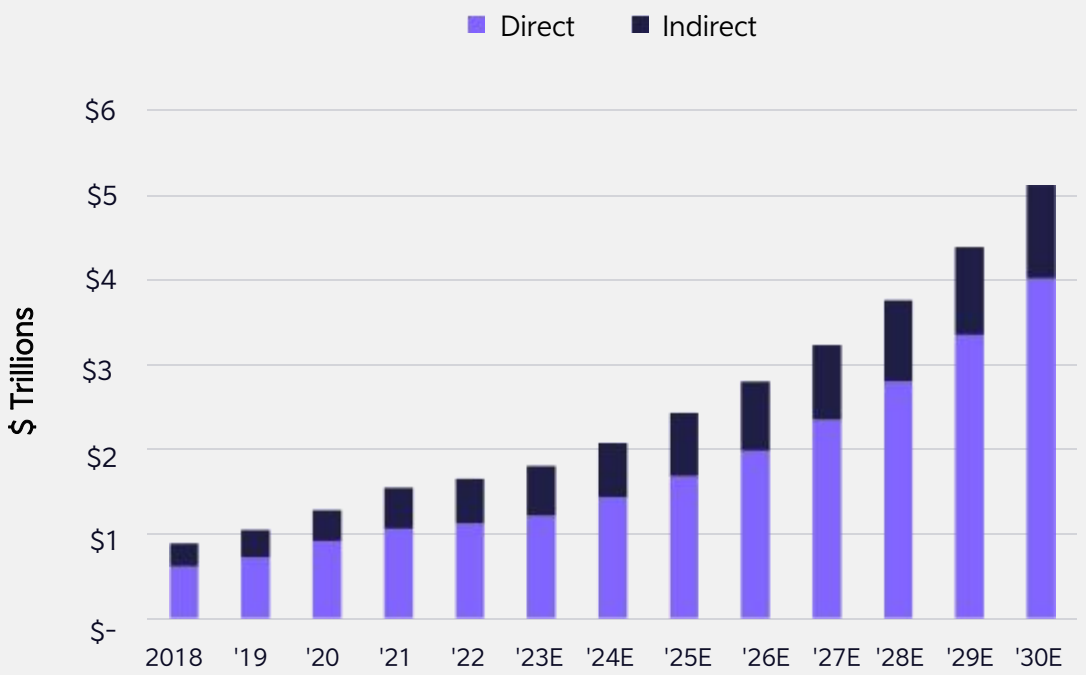
数字消费超过经济增长

在全球范围内，到2023年，消费者将其34万亿美元休闲预算的20%用于数字化的商品和服务。基于向数字休闲的转变，未来七年，实际数字收入 * 可能会以每年16%的速度增长，从18万亿美元增至5万亿美元，占2030年所有休闲支出的43%。

Global Digital Leisure Spend**



Global Digital Platform Revenue



*We define digital platform revenue as the gross revenues of US sports betting, global video game software and services, global digital video, and global digital audio. We also include net e-commerce platform revenue and net NFT creator fees and platform revenue on a global basis. **Direct includes spend across e-commerce, video game software, digital video, digital audio, NFTs, and US mobile sports betting. Indirect includes spend across all digital ads. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Research By: **Andrew Kim**
Analyst

数字钱包

双边网络的闭环

本报告为ARK投资出品的年度研究报告，智能小巨人科技进行了编译，仅供学习参考，请勿用于商业用途

Sources: ARK Investment Management LLC, 2024. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

垂直软件是指针对特定行业需求量身定制的一套解决方案。领先的垂直软件平台正在迅速扩展到面向消费者和商家的金融服务领域。
利用双边网络，这样的软件可以促进从消费者到商家、商家到雇员以及雇员到商家的闭环交易。
ARK认为，这些平台上的数字钱包将实现完全封闭的支付生态系统。

Block，Shopify和Toast是引人注目的平台，可能会使用数字钱包作为其消费者，商家和员工生态系统的核心。
根据我们的研究，闭环消费者支付，商业银行和员工工资/支付可以在未来七年内以每年22-33% 的速度增加他们的收入。从2023年的70亿美元到2030年的270-500亿美元。*

*In this exercise, we forecast the core revenues of Block, Shopify, and Toast to grow 22% at an annual rate over the next seven years. Summing the mentioned revenue opportunities on top of our core revenues forecast increases the annual growth rate from 22% to 33% over the next seven years. We primarily model Block's historical revenue and future revenue opportunity across its Square merchant ecosystem and do not incorporate Cash App or Afterpay revenues independent of Square. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

垂直软件平台正在整合金融服务

除了支持核心业务运营之外，Block、Shopify和Toast等垂直软件提供商正在整合商家的金融服务。以数字钱包为核心，与赞助银行和金融科技公司合作或激活自己的银行章程，垂直平台应消除与效率较低的传统金融机构的无数商家互动。

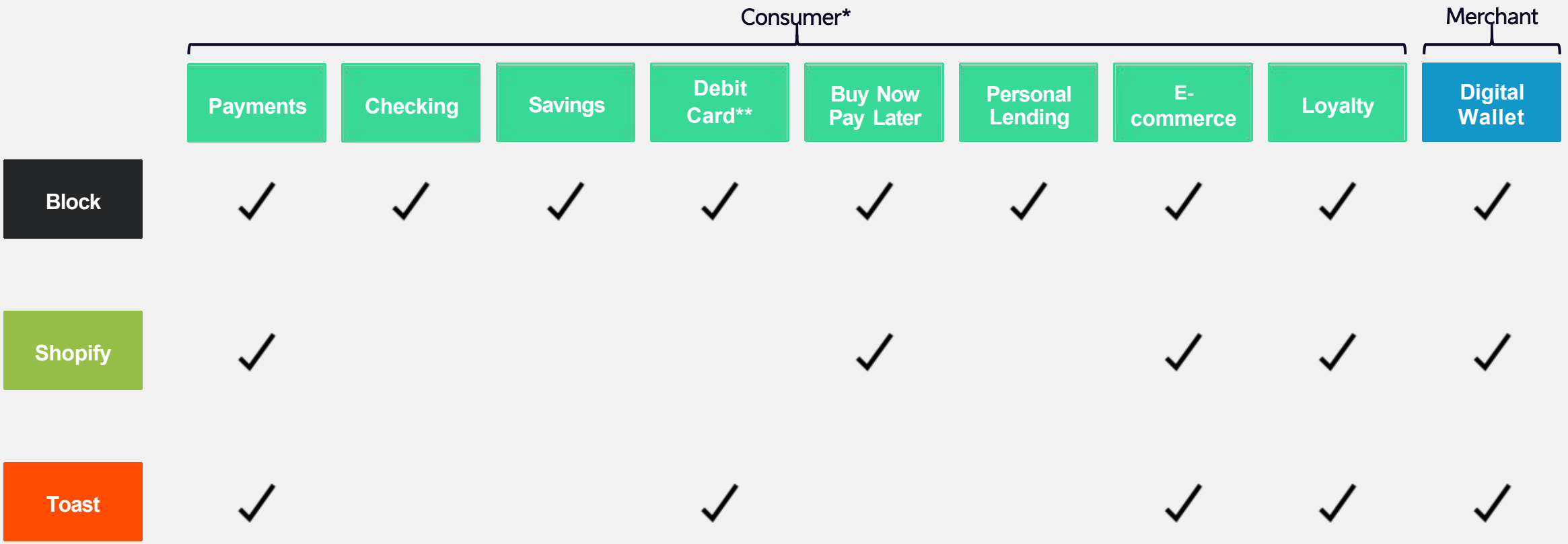
	Consumer*	Merchant						
	Digital Wallet	Payroll	Checking	Savings**	Debit Card	Credit Card	Working Capital Financing	Bill Pay***
Block	✓	✓	✓	✓	✓	✓	✓	✓
Shopify	✓		✓	✓	✓	✓	✓	✓
Toast	✓	✓			✓		✓	✓

*We consider Block’s Cash App and Toast’s MyToast mobile app as consumer digital wallets, and we consider Shopify’s Shop mobile app and Toast’s Toast Takeout mobile app as digital wallets in their early stages. **We consider Shopify Balance as both a checking and savings vehicle for merchants. ***Given xtraCHEF’s invoice automation features, we believe Toast will soon offer direct bill pay on its platform. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Big Ideas 2024—智能小巨人科技编译版

垂直软件平台正在整合消费者服务

垂直软件平台不仅支持庞大的商业网络，还使用数字钱包构建消费者网络。通过同时扩展商家和消费者网络，垂直软件平台正在成为这些双边网络的操作系统。

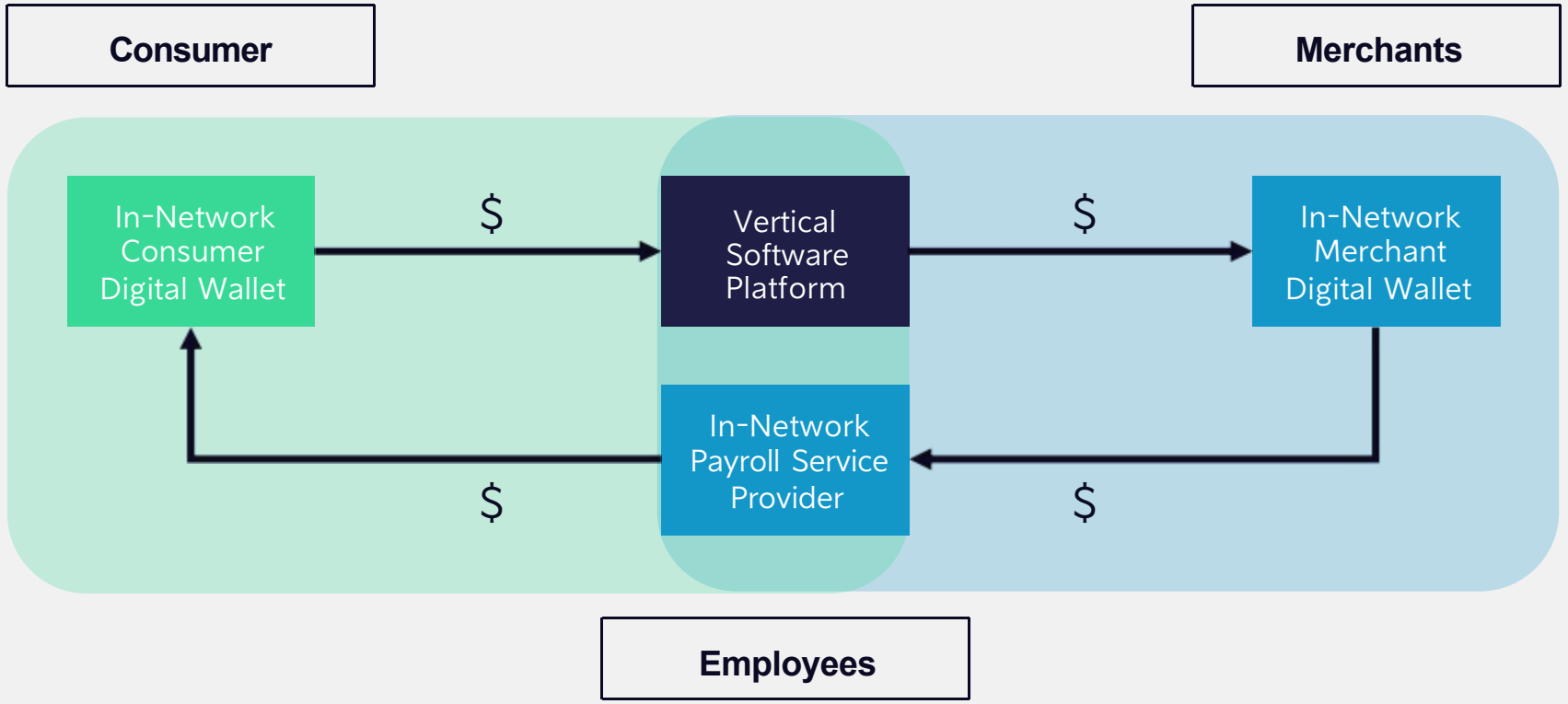


*We consider Block's Cash App and Toast's MyToast mobile app as consumer digital wallets, and we consider Shopify's Shop mobile app and Toast's Toast Takeout mobile app as digital wallets in their early stages. **We consider the Toast Pay Card a form of consumer debit cards. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

双边网络可以关闭消费者和商家之间的金融循环

闭环支付生态系统通过三种方式整合网络内资金转移: 从消费者到商家，从商家到员工，以及从员工-消费者-到商家。

要构建这些支付生态系统，平台必须具备: 1) 大型的双边网络，2) 对商家的运营和财务的端到端可见性，以及3) 垂直行业专业知识。

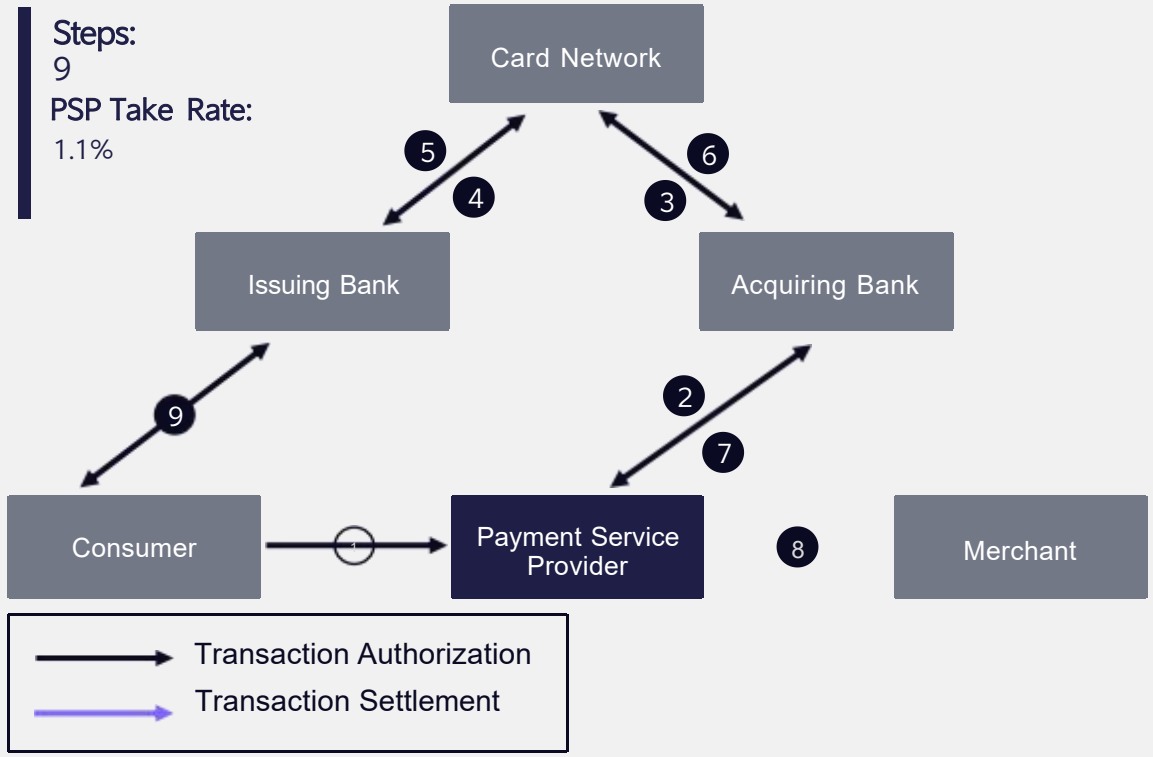


Sources: ARK Investment Management LLC, 2024. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

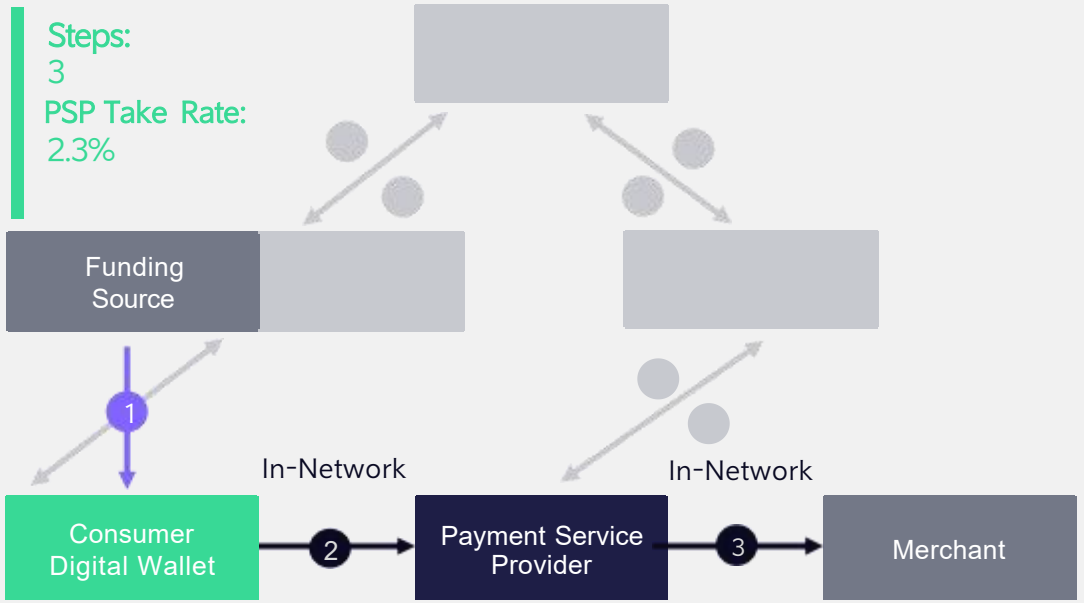
数字钱包可能导致消费者对企业 (C2B) 支付生态系统的去中介化

用数字钱包余额资助的交易绕过了银行和发卡网络，为支付服务商、商家和消费者节省了交换费。在ARK看来，具有规模化消费者和商家生态系统的垂直软件平台将利用数字钱包来促进闭环交易。*

BEFORE: C2B Card Payment Authorization



AFTER: C2B Closed-Loop Payment Authorization

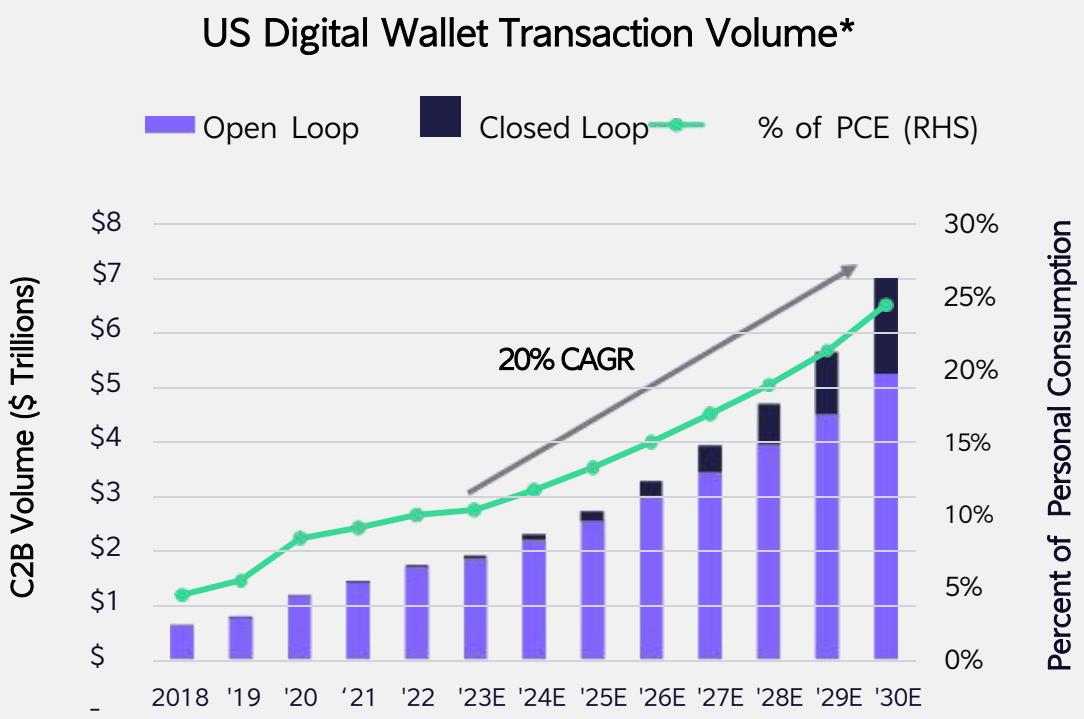


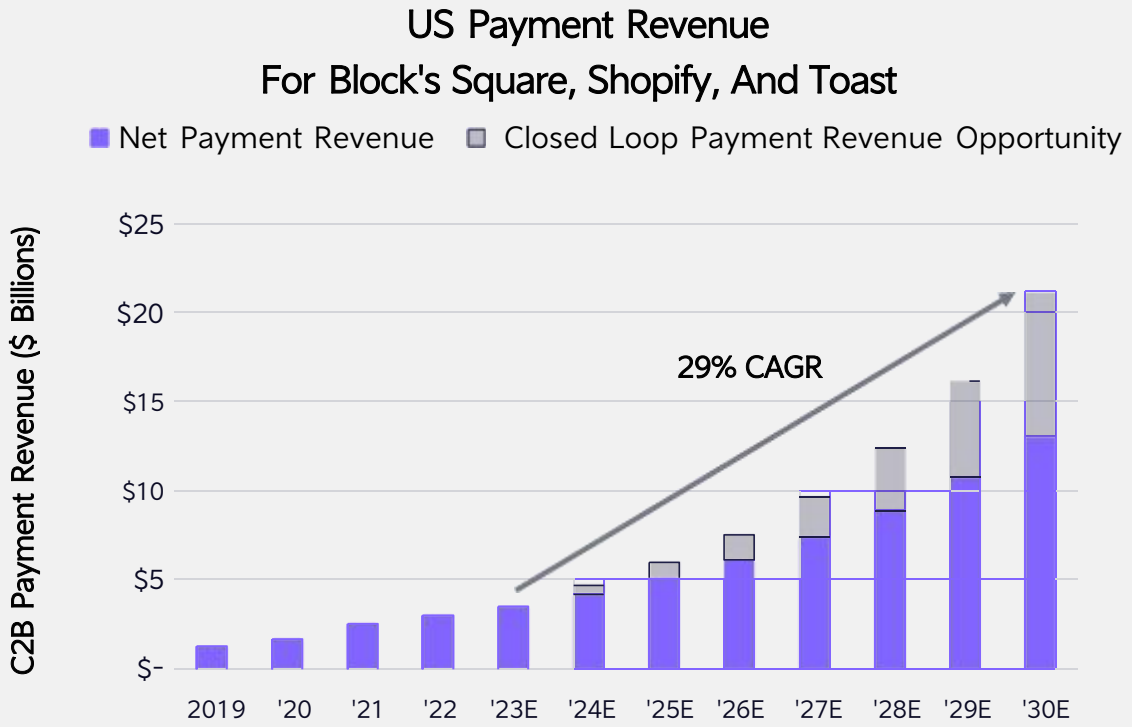
*Payment processes and associated fee estimates are rendered for illustrative purposes only. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

美国的闭环支付量未来七年将超速增长

根据ARK的研究，C2B数字钱包支付总额将在未来七年内以每年20%的速度增长，从2023年的约2万亿美元增加到2030年的约7万亿美元。作为总数的百分比，闭环支付应该从大约4%增加到25%。

以Block's Square，Shopify和Toast支付的收入，预测从35亿美元增长至210亿美元，年化收益率为29%。**

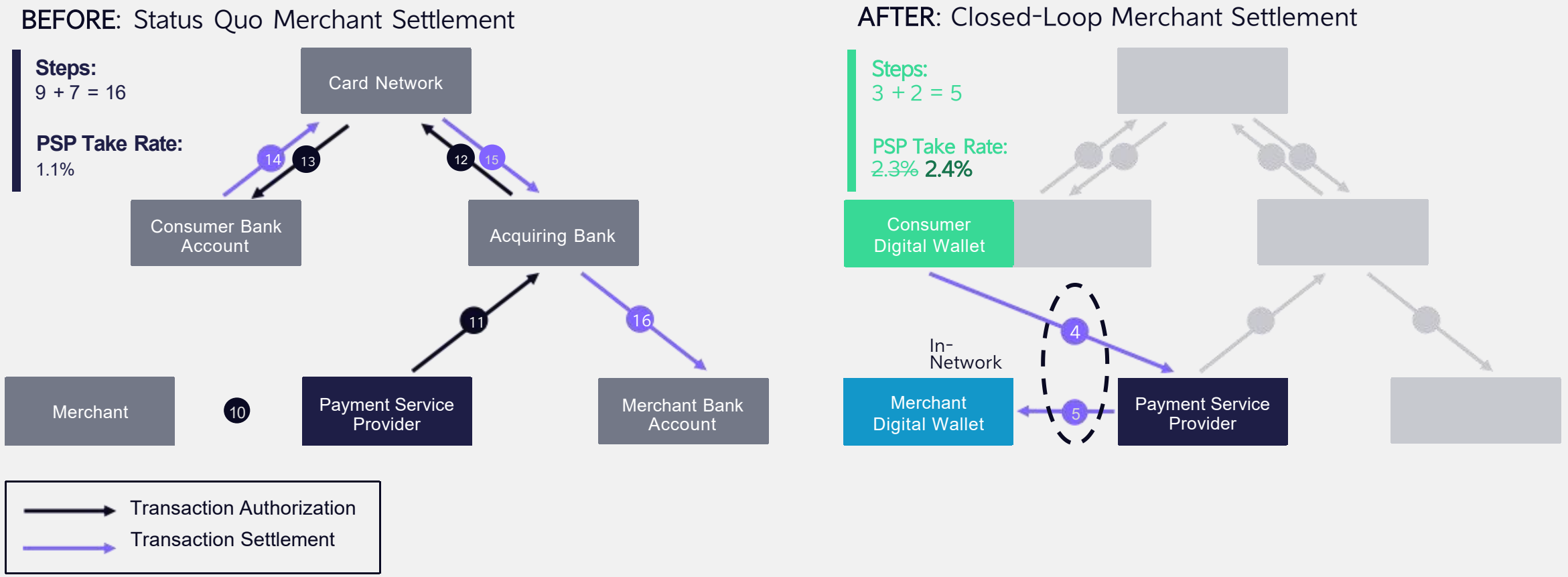




*We define closed-loop transactions as any consumer-to-buyer (C2B) digital wallet transaction that does not involve third-party issuers or card networks except for digital wallet balance top-ups. **Closed-loop payment revenue is represented on a gross basis and will be shared between the software platforms and all enabling market participants such as other fintechs or sponsoring financial institutions. We primarily model Block’ s historical revenue and future revenue opportunity across its Square merchant ecosystem and do not incorporate Cash App or Afterpay revenues independent of Square. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including Worldplay 2019, 2020, 2021, 2022, 2023, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

数字钱包将使商业银行业务去中介化

垂直软件平台可以为商家提供金融服务。通过数字钱包，这些平台不仅提高了便利性，而且还将存款货币化，将从支付授权到商家结算的步骤从16个减少到5个，并使平台的使用率提高了一倍以上。*



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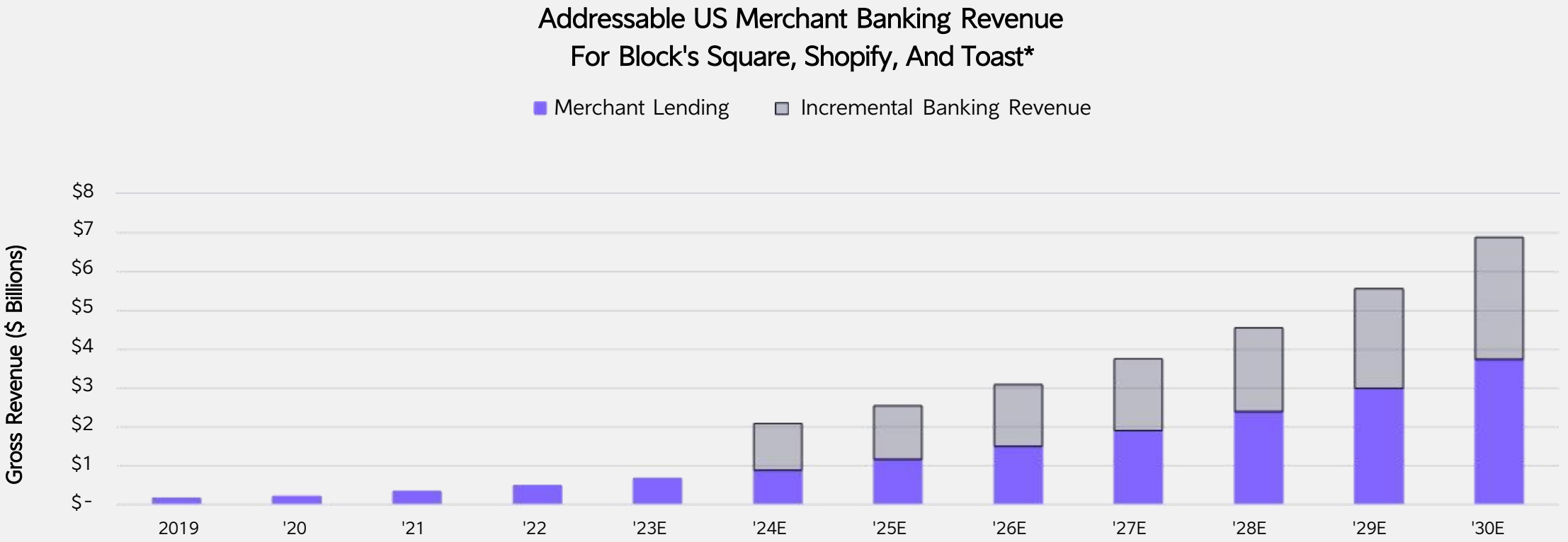
到2030年，商家数字钱包收入可能会翻一番

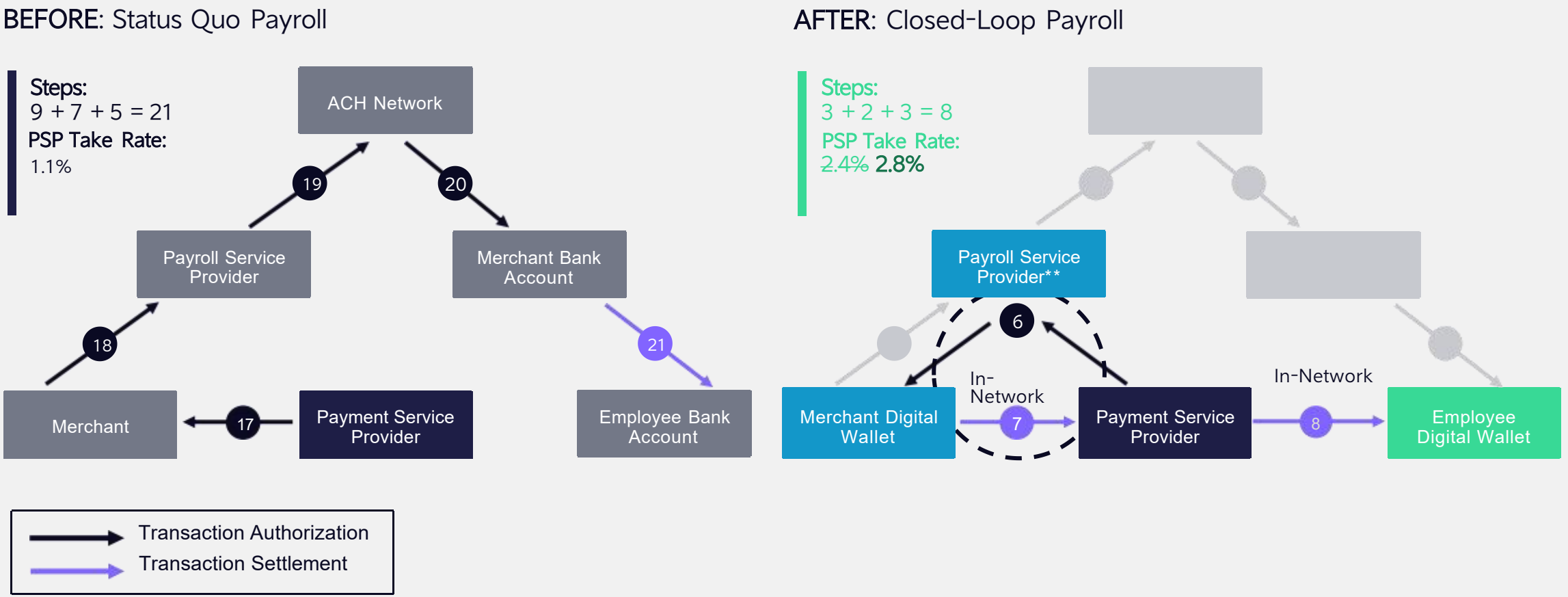
如果净存款收益率等于大型商业银行的收益率，那么与Block's Square，Shopify和Toast相关的商业银行收入在未来七年内可能以每年40%的速度增长。从2023年的7亿美元到2030年的70亿美元。在70亿美元的大盘规模中，这三个平台在美国商业支付总收入中的份额将增加5倍。从今天的0.3%到2030年的1.6%。



*Our incremental banking revenue forecast intends to capture both net interest income and noninterest revenue associated with merchant deposits and lending that are not already included in our forecast for Block, Shopify, and Toast’s working capital financing business. Both line items are represented on a gross basis and will be shared between the software platforms and all enabling market participants such as other fintechs or sponsoring financial institutions. This forecast does not directly include revenue from instant transfers, corporate card issuance and spend management, or bill pay. We primarily model Block’s historical revenue and future revenue opportunity across its Square merchant ecosystem and do not incorporate Cash App or Afterpay revenues independent of Square. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including McKinsey & Company 2018, 2019, 2020, 2021, 2022, 2023, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

数字钱包可能会降低薪资银行的机会

垂直软件平台可能会使用数字钱包将商家直接与员工联系起来，增加货币化机会，几乎没有客户获取成本。*

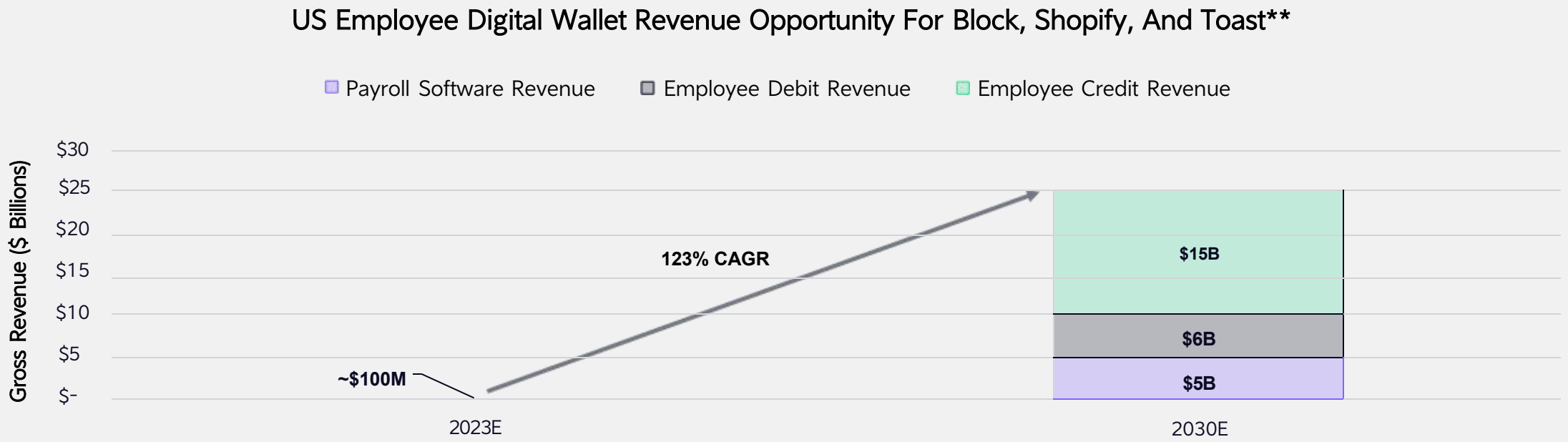


*Payment processes and associated fee estimates are rendered for illustrative purposes only. **In this example, we assume the PSP offers a first-party or white-labeled third-party payroll solution. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

员工数字钱包代表着250亿美元的潜在收入机会

与消费者钱包一样，员工数字钱包可以发展成为针对特定行业定制的全面金融应用程序。员工工资单和付款可能会成为Block、Shopify和Toast的引人注目的货币化流。

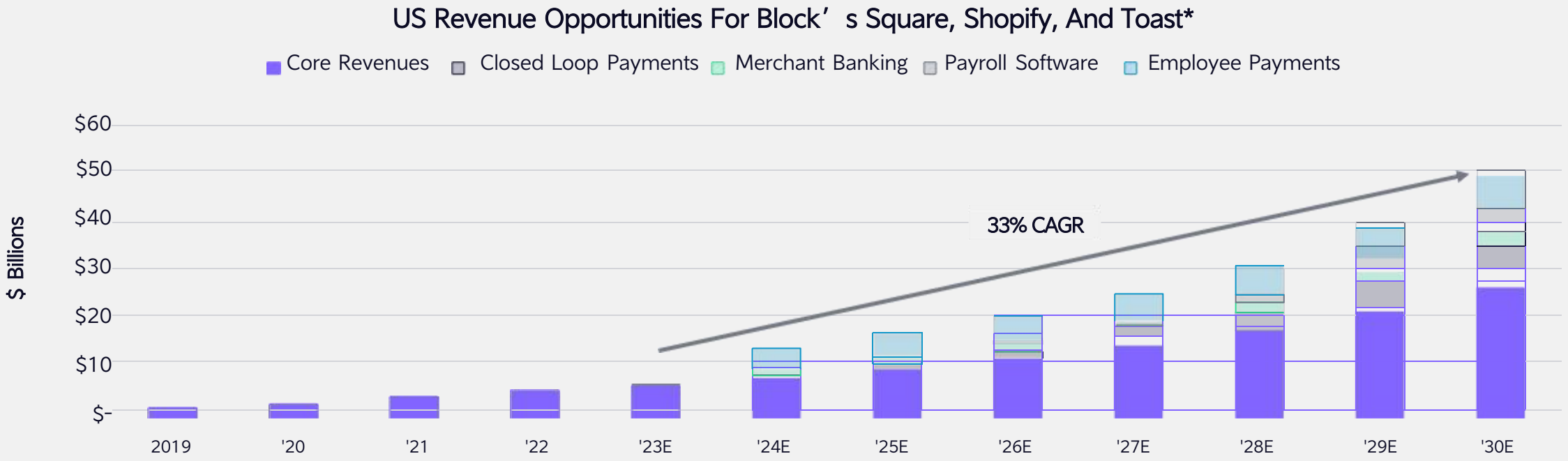
根据我们的研究，到2030年，员工数字钱包可以在1万亿美元的潜在薪资机会中产生250亿美元的总收入。* 如果这些平台能够抓住100%的机会，员工数字钱包收入可能在未来七年内以每年123%的速度增长。



*Our forecasted ~$1 trillion in annual payroll aggregates our forecasts for Block, Shopify, and Toast's merchant base, employee base, and average payroll across addressable verticals such as retail, accommodations and food services, other consumer services, professional services, and other consumer entertainment. **All revenue is represented on a gross basis and will be shared between the software platforms and all enabling market participants such as other fintechs or sponsoring financial institutions. Payroll software revenue does not include float revenue, and we do not adjust for duplicate employee debit and credit revenues that may already be embedded in consumer payment revenue. We primarily model Block's historical revenue and future revenue opportunity across its Square merchant ecosystem and do not incorporate Cash App or Afterpay revenues independent of Square. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

数字钱包可以产生230亿美元的垂直软件收入

根据ARK的研究，Block的Square，Shopify和Toast的核心收入将在未来七年内以每年22%的速度增长。从2023年的70亿美元到2030年的270亿美元。闭环消费者支付、商业银行和员工工资/支付可能会额外产生230亿美元，到2030年，收入年增长率将从22%提高到33%。



*Core revenues include software revenue, net open-loop payment revenue, merchant lending revenue, and revenue attributable to all other extant business lines. Merchant banking revenue includes both net interest income and noninterest revenue attributable to merchant deposits and lending not already captured by our forecast for Block, Shopify, and Toast’s working capital financing business. All revenue segments excluding net open-loop payment revenue, closed-loop payment revenue, and employee payment revenue are represented on a gross basis, and all revenue will be shared between the software platforms and all enabling market participants such as other fintechs or sponsoring financial institutions. We use our status quo forecasts the software platforms’ net take rates to estimate net employee payment revenue and do not explicitly estimate incremental cost synergies from employee closed-loop payments. We view all revenue segments except for core revenues not as explicit forecasts but as addressable opportunities in the US for Block’s Square, Shopify, and Toast. We primarily model Block’s historical revenue and future revenue opportunity across its Square merchant ecosystem and do not incorporate Cash App or Afterpay revenues independent of Square. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Research By:
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Analyst
Pierce Jamieson
Analyst
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Research Associate

精准医疗

更有效，更便宜地治愈疾病

Sources: ARK Investment Management LLC, 2024. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

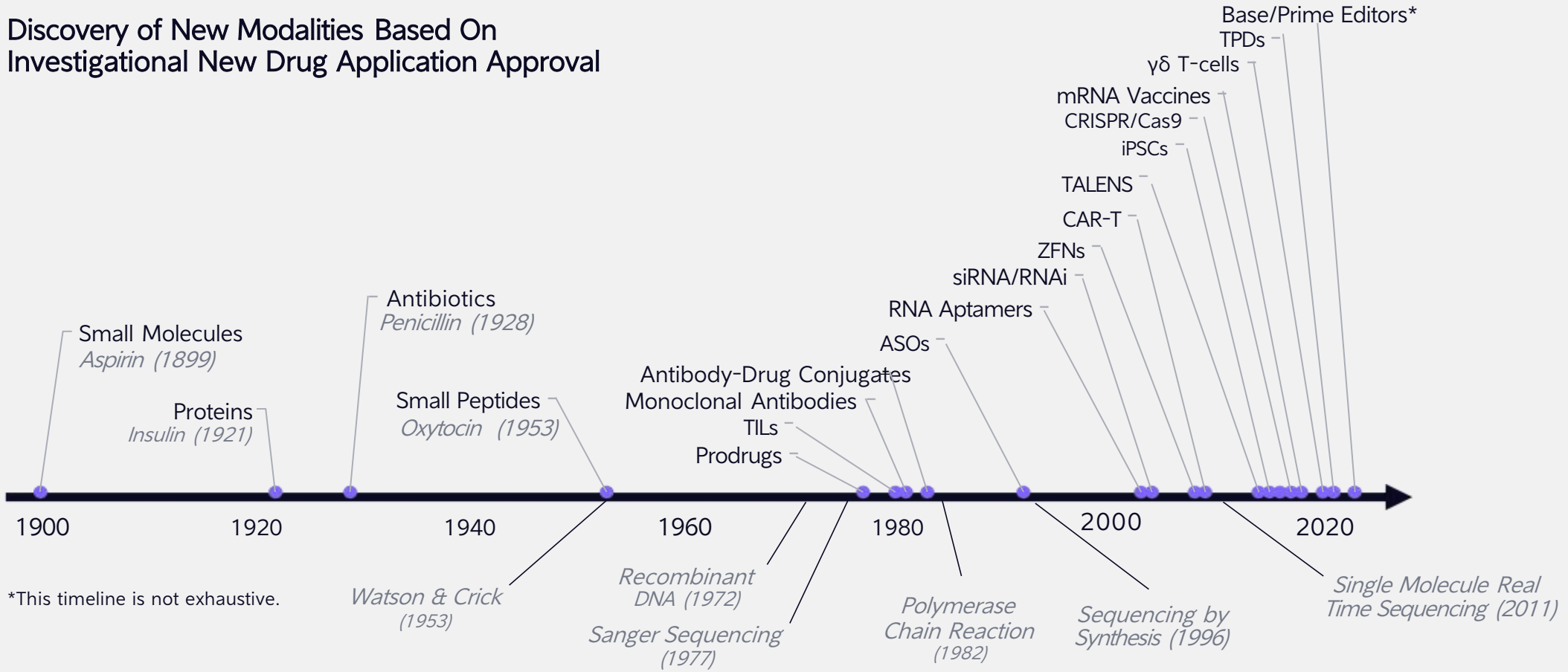
在过去的二十年里，精准治疗、CRISPR基因编辑、RNA治疗和靶向蛋白质降解的新模式已经激增。由人工智能 (AI) 、CRISPR基因编辑和新测序技术驱动的创新疗法增加了研发 (R & D) 的回报，同时使不可药物治疗的目标变得可药物治疗。

越来越多的精准疗法正在成为多学科和治愈性的，其作用机制涵盖DNA，RNA，蛋白质等。根据ARK的研究，专注于精准治疗的公司的企业价值在未来七年内可能会以每年28%的速度增长，从2023年的8200亿美元增长到2030年的4.5万亿美元。

Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

新的治疗方式正在激增

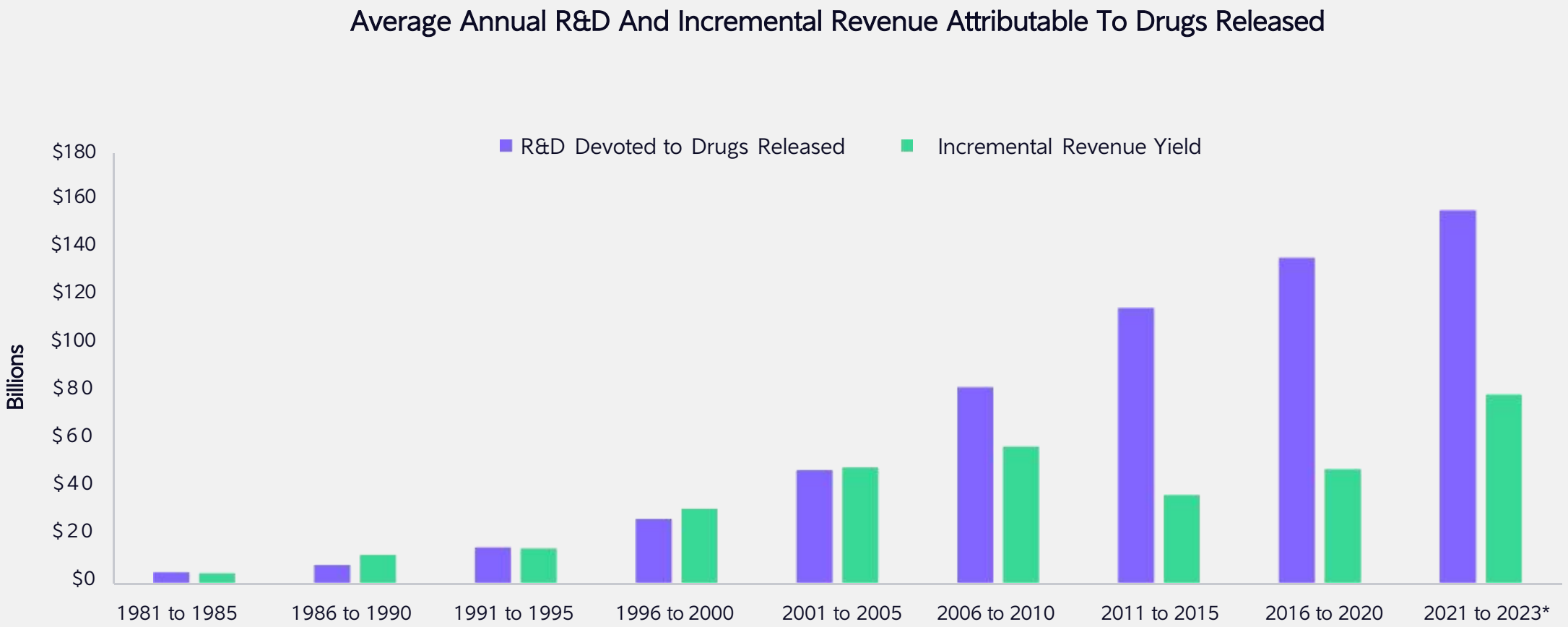
在过去的三十年中，具有全新作用机制的治疗方式的数量激增。它们不仅扩大了可治疗疾病的数量，而且还提高了疗效和安全性。2023年，超过25% 的临床试验正在利用新的治疗方式。



Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of external sources, including Biomedtracker, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

精准疗法可以扭转研发 (R&D) 回报的下降趋势

鉴于监管瓶颈和传统的药物发现方法，治疗研发的回报在近25年时间里持续下降。根据我们的研究，新的治疗方式和研发方法，加上监管部门对 “精准” 疗法的批准，可以扭转制药行业投资回报率下降的趋势。

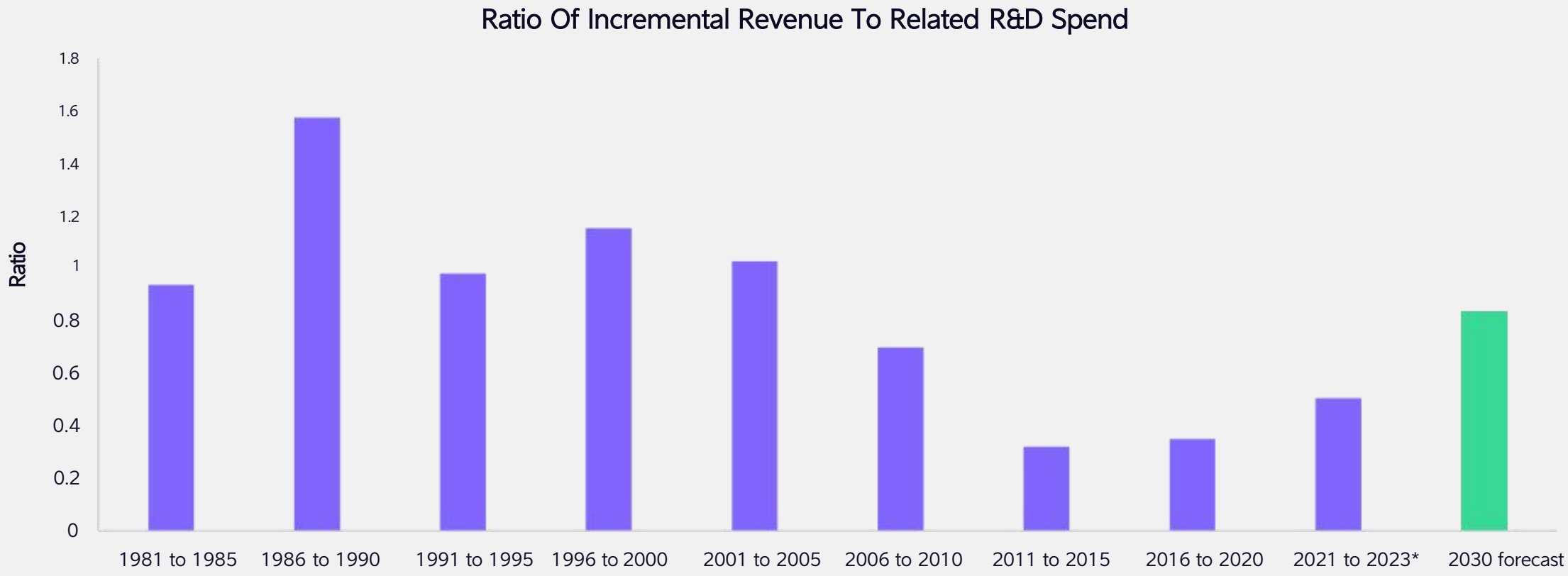


*Shorter time frame. Data impacted due to COVID.

Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of external sources, including Biomedtracker and Ycharts, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

精准疗法可以扭转研发回报的下降趋势

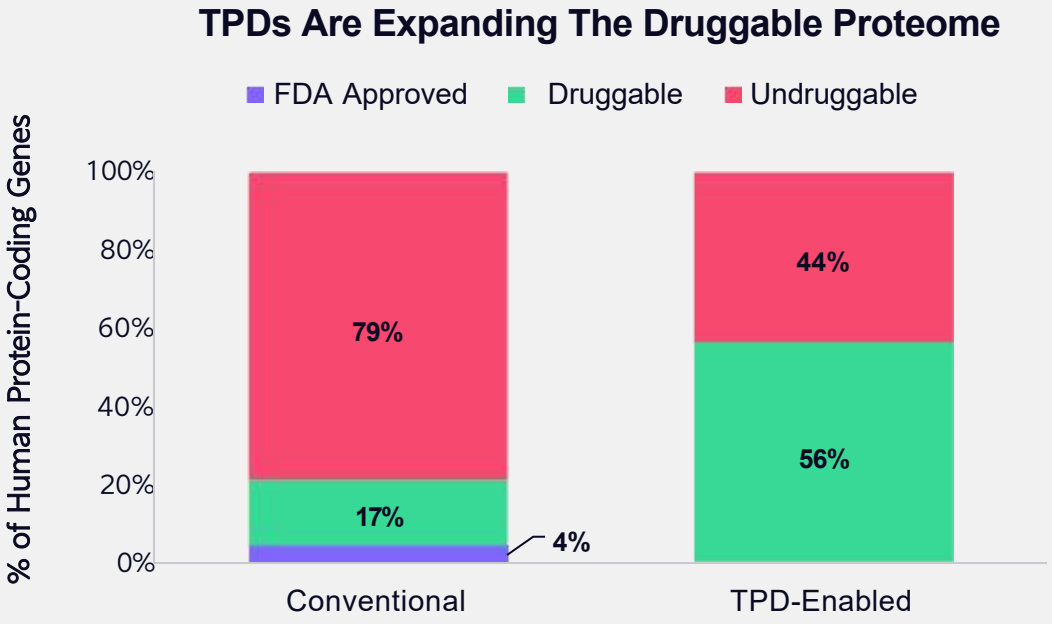
鉴于监管瓶颈和传统的药物发现方法，到2020年，治疗研发的回报总体上下降了约35年。允许新的治疗方式和研发方法实现 “精确” 疗法的法规可能会在未来五到十年内扭转下降趋势。

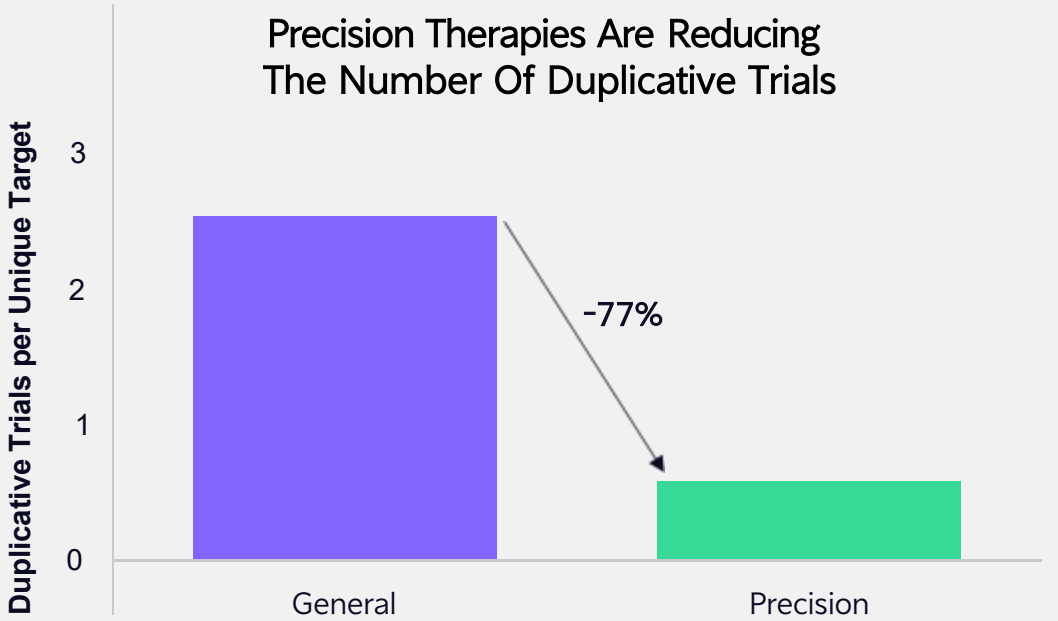


Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of external sources, including Biomedtracker and Ycharts, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

精准疗法正在帮助治疗以前无法治愈的疾病

精准疗法，包括基于RNA的药物和 “靶向蛋白质降解剂” (tpd)，不仅扩大了人类基因组中可药用蛋白质的数量，还有可治疗组织类型的数量。





人类基因组包含约20，000个蛋白质编码基因，其中只有864个 (4.3%) 与FDA批准的药物相关。Human Protein Atlas估计79% (约15，800) 的人类蛋白质是不可使用的。我们的研究表明，TPDs和相邻技术可以处理56% (约11，200) 的人类蛋白质编码基因。

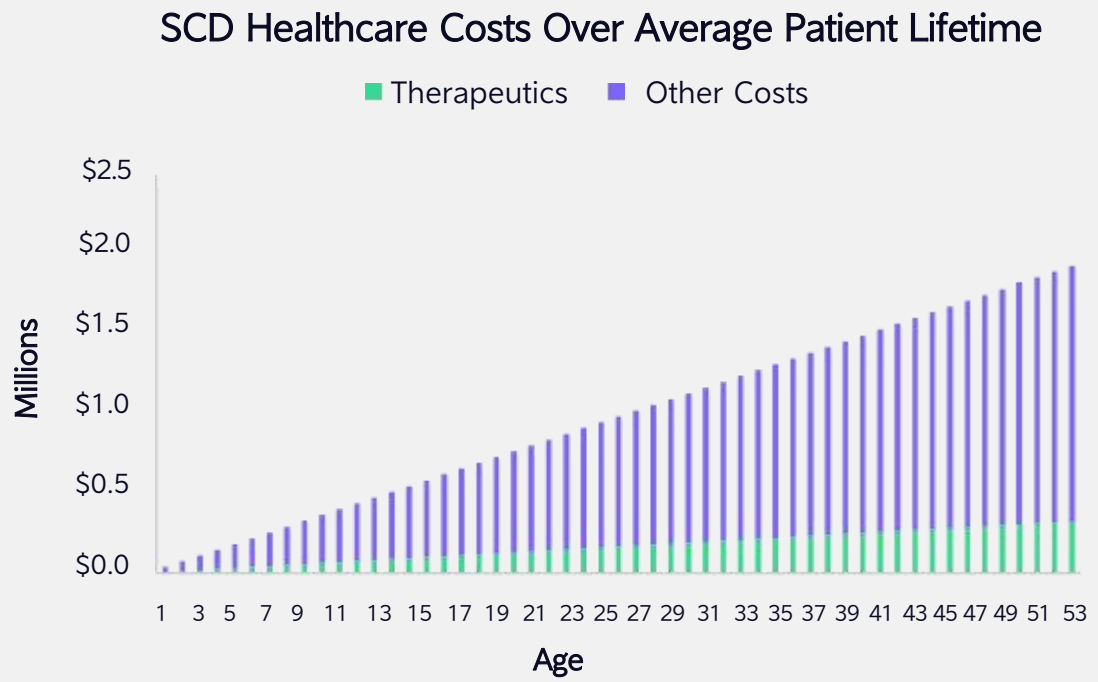
先进的精确治疗试验正在测试比现状治疗更广泛的生物学目标，重复试验的数量减少了77%。因此，科学家们在每一美元的研发中测试了更多的生物目标，增加了确定独特和成功疗法的可能性。

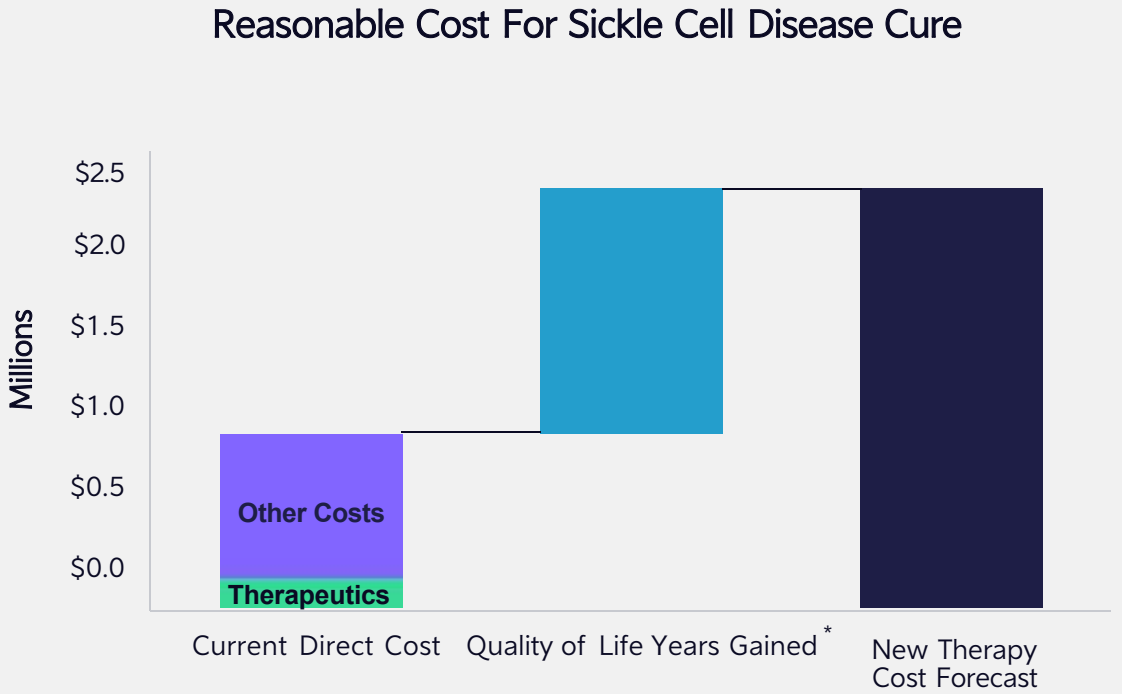
Data are as of December of 2023

Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon.
For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

治疗镰状细胞性贫血等罕见疾病的价值很高

在精准疗法中，像CRISPR-Cas9这样的基因编辑药物有可能治愈罕见的遗传疾病，如镰状细胞病 (SCD)。SCD是一种遗传性红细胞疾病，在美国影响超过10万人，在全球有2000万人，主要在非洲。今天，治疗学占美国治疗SCD疾病总支出的约16%，但他们所做的只是控制症状，因为SCD患者的预期寿命仅为一般人群的56%。





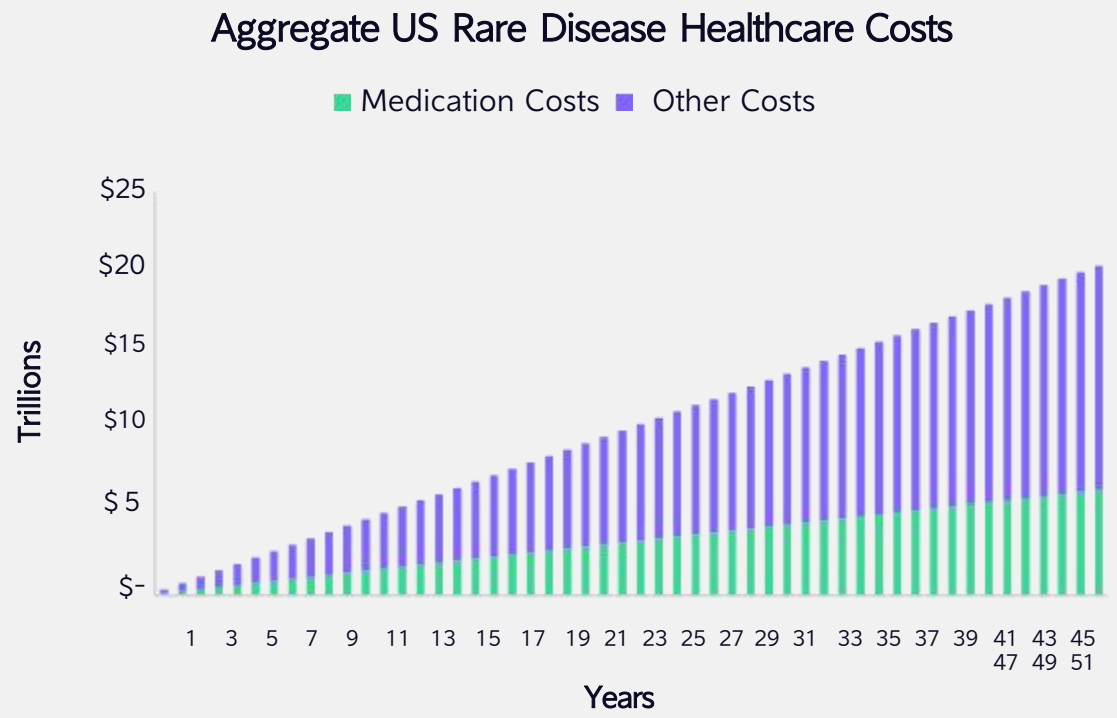
*Quality of Life Years Gained = Health Utility * Duration
For Health Utility, 0 means dead and 1 means full health

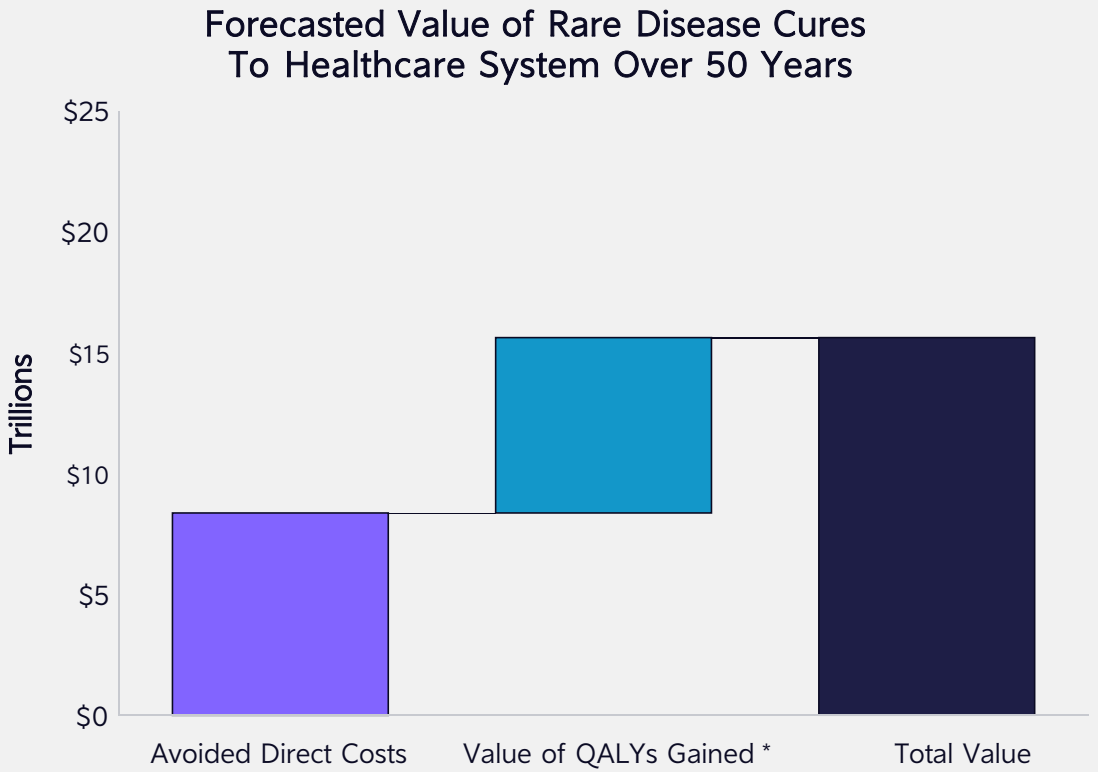
Data are as of December of 2023.

Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

治愈所有罕见疾病非常有价值

美国医疗保健系统每年花费约4500亿美元用于治疗罕见疾病。为了在一生中管理患有罕见疾病的患者，费用可能会增加到20万亿美元，其中不到一半将用于药物治疗。从理论上讲，治愈所有罕见疾病将把大部分费用转移到药物治疗上，消除了住院和门诊疾病管理的需要，强调了治愈的价值。





*Quality of Life Years Gained = Health Utility * Duration
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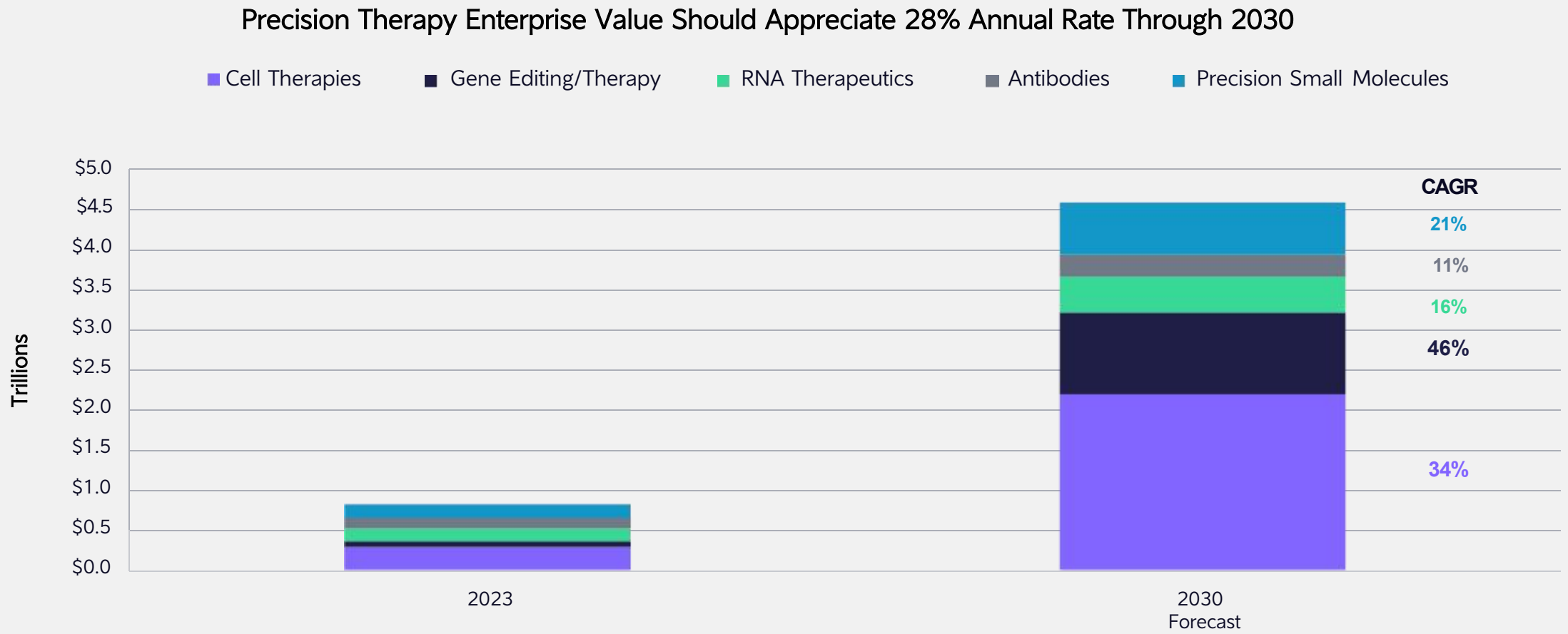
Data are as of December of 2023

Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of external sources, including Orphanet 2023, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

把握机会: 精准疗法

基于我们的研究，随着CRISPR基因编辑、测序和人工智能 (AI) 等技术创造精准疗法，未来七年，精准治疗公司的企业价值应以28% 的复合年增长率 (CAGR) 升值，从2023年的8200亿美元增加到2030年达4万亿美元。



Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of external sources, including S&P Capital IQ Data and Biomedtracker, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Research By: Pierce Jamieson
Analyst
Nemo Marjanovic
Research Associate

多组学工具与技术

将生物学见解转化为更好的医疗保健和经济价值

Sources: ARK Investment Management LLC, 2024. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

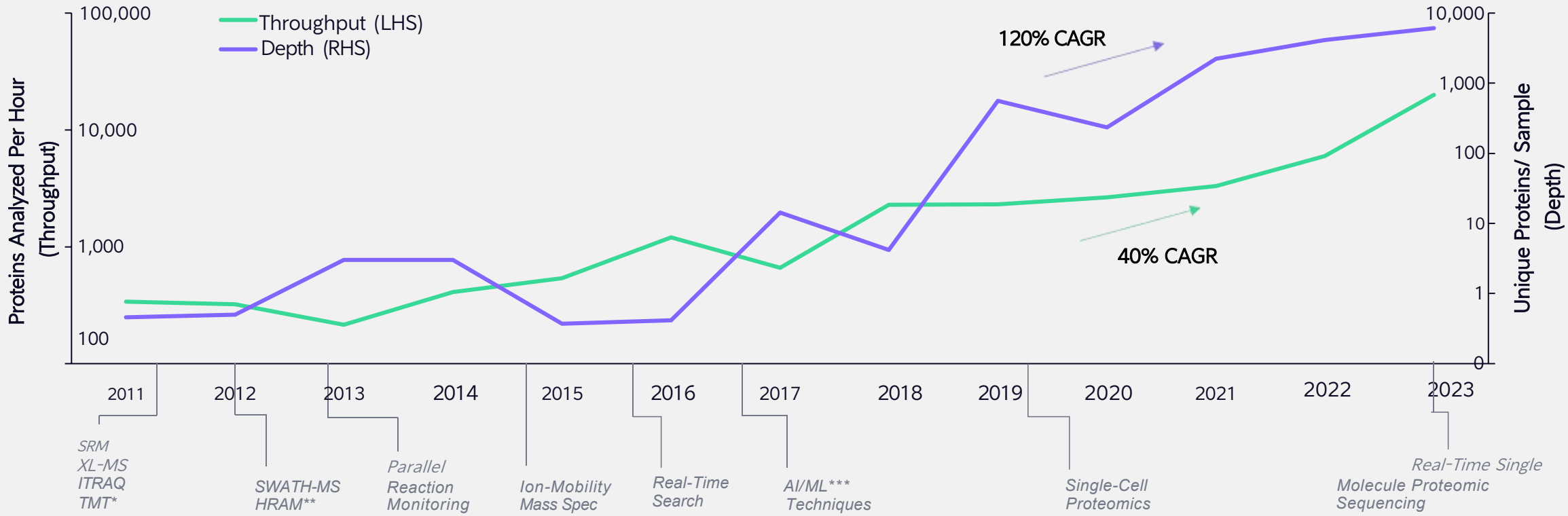
在过去的十年中，生物工具和技术的数量激增，其能力显着提高。其中，三种使能技术脱颖而出: 高通量蛋白质组学、人工智能和单细胞测序。它们的融合提高了生产力和效率，提高了医疗保健应用的精度，并释放了巨大的经济价值。

根据ARK的研究，这些技术可以将每种药物的研发 (R & D) 支出减少25% 以上。在未来七年内，精准治疗领域的企业价值可能以26%的复合年增长率增加，从2023年的8200亿美元增加到2030年的4.5万亿美元。

Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

蛋白质组通量和深度呈指数级增长

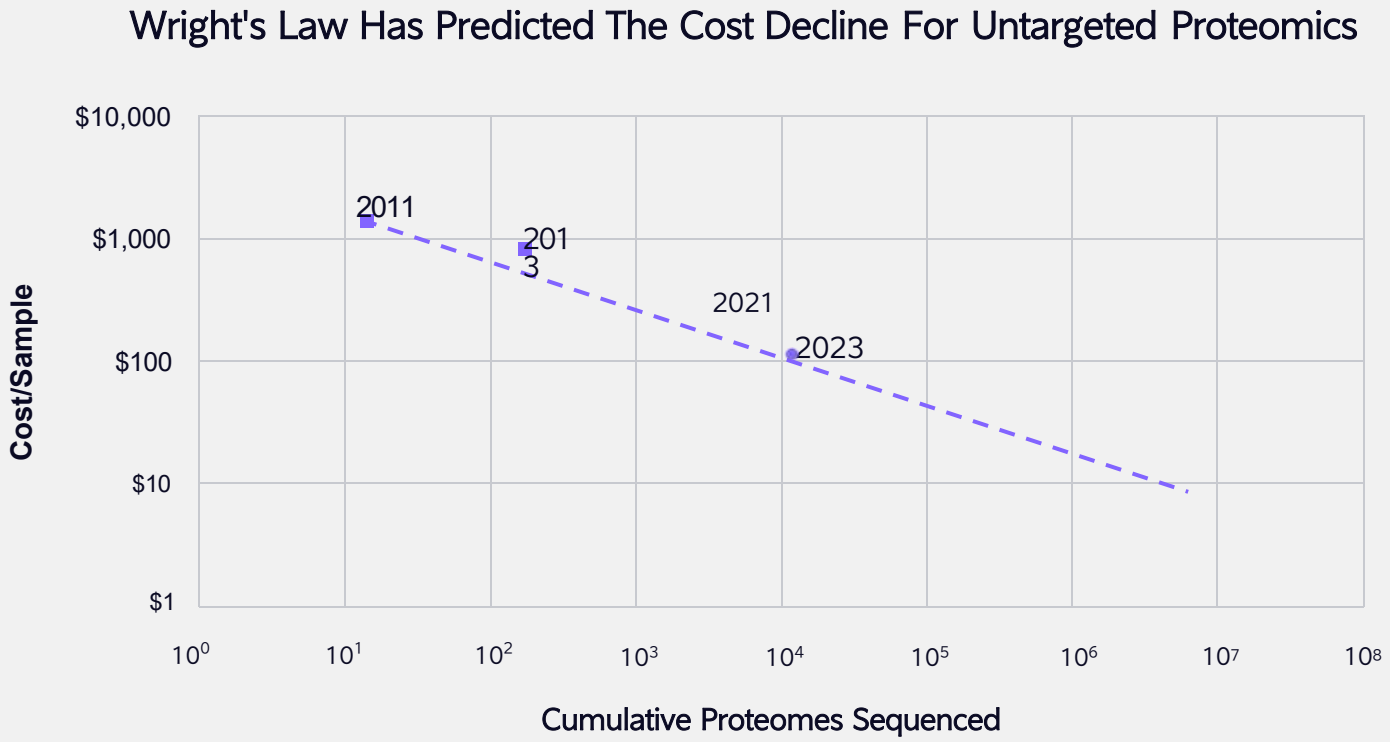
在过去的十年中，质谱和生物信息学的进步极大地改善了蛋白质组学分析，提高了分辨率，准确性和同时分析多个样品的能力。这些发展不仅能够详细探索健康和疾病中的蛋白质组，而且还加速了癌症生物标志物的发现和靶向疗法的发展。

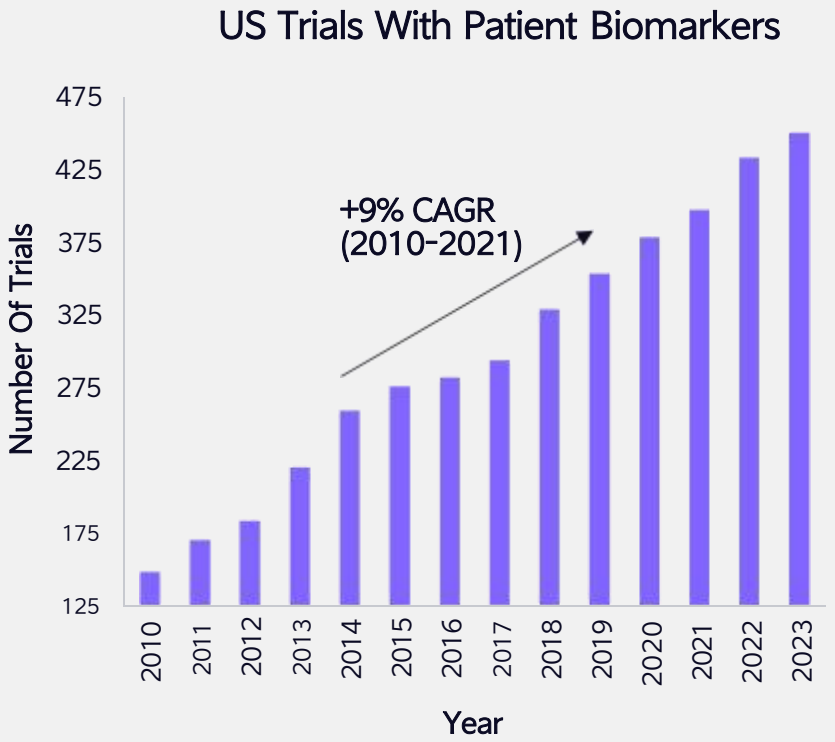


*SRM: Single reaction monitoring; XL-MS: cross-linking mass-spectrometry; ITRAQ: isobaric tagging; TMT: tandem mass spectrometry. **SWATH-MS: sequential window acquisition of all theoretical fragment ion spectra mass spectrometry. ***AI/ML: Artificial Intelligence/Machine Learning. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of external sources, including Peters-Clarke et al. 2023, and Zhang and Cui 2022, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

赖特定律预测了蛋白质组学的成本下降

随着通过质谱分析的蛋白质组数量的增加，成本大幅下降，为医学研究和诊断开辟了新的可能性。我们的研究表明，对于使用质谱的非靶向蛋白质组学，每个样品的成本以23%的年率下降，或者说，测序的蛋白质组数量每增加一倍，成本下降约11%。蛋白质组学的发现为鉴定新型生物标志物铺平了道路，使早期检测和治疗独特的癌症亚型成为可能。

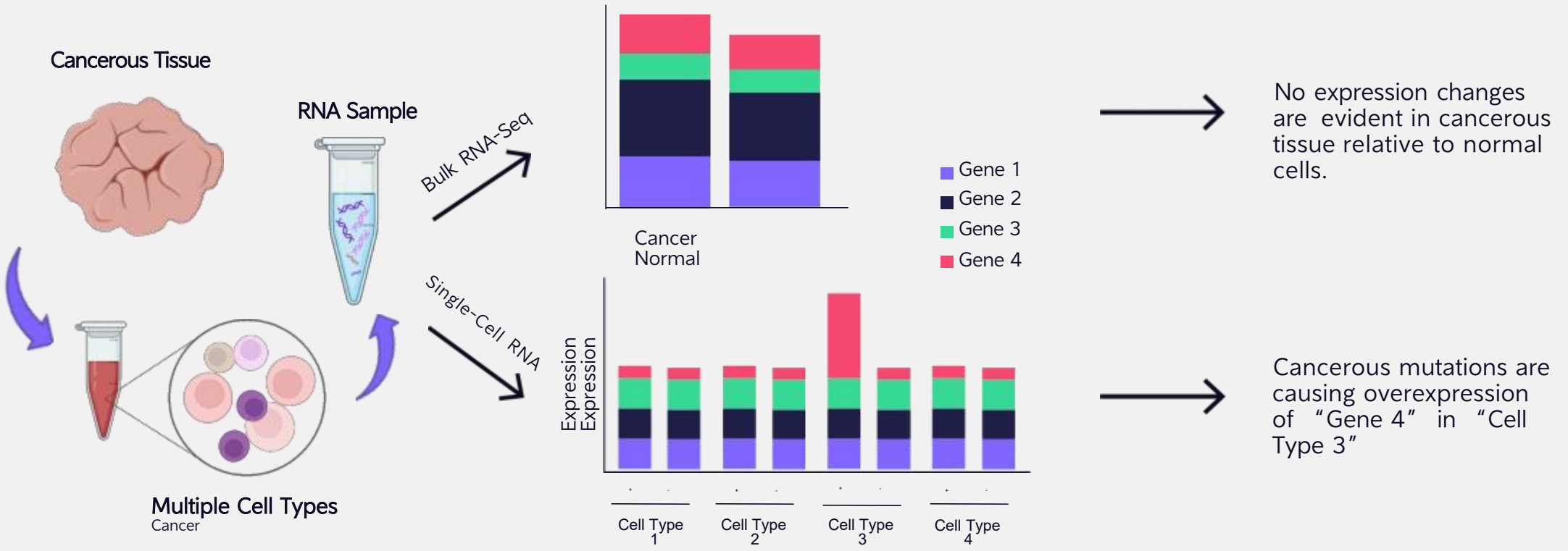




Wright's Law states that for every cumulative doubling of units produced, costs will fall by a constant percentage. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

单细胞RNA测序正在彻底改变我们对癌症的理解

虽然使用rna-seq的传统基因表达分析只能测量不同细胞类型混合物中基因的表达，但单细胞rna-seq (scrna-seq) 可以描绘复杂组织样品中不同细胞类型的表达。从理论上讲，将基因表达与特定细胞联系起来可将测量精度提高10倍，并将每gb的成本降低76%。



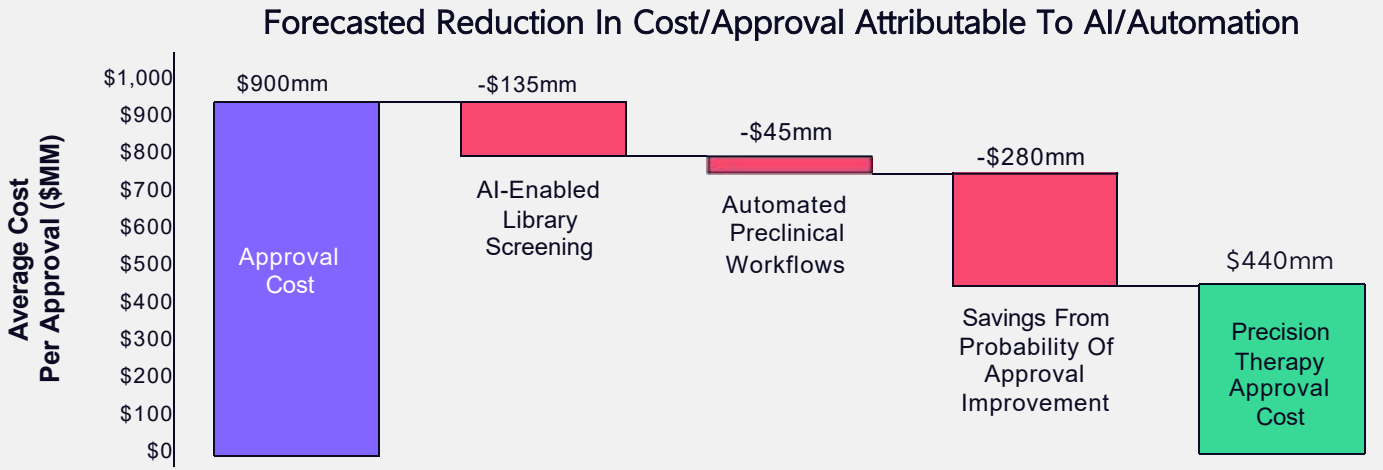
Sources: ARK Investment Management LLC, 2024. Illustration created with BioRender.com, based on data from Hwang et al. 2018. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

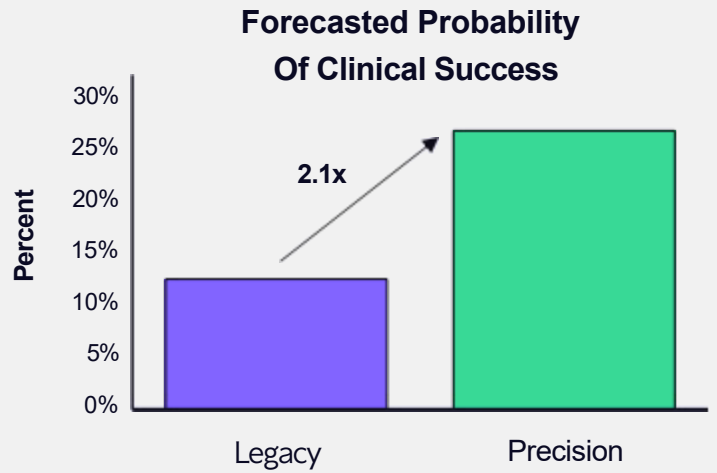
人工智能和自动化正在推动药物发现

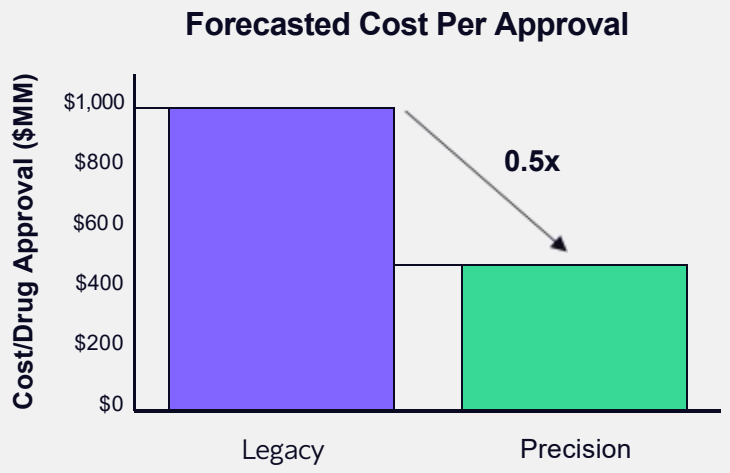
在药物发现过程中实施人工智能/机器学习 (AI/ML) 增加了药物开发人员可以从虚拟和物理库中筛选的潜在活性化合物的数量。

高通量自动化工作流程 (如药物微合成和体外/体内测定) 对于利用AI支持的药物发现至关重要。

在未来十年内，实施AI/ML药物发现方法和自动化工作流程的公司可能会将其从第一阶段到批准的临床成功概率提高一倍。在此过程的早期，消除化合物和提高生产率应将单一药物批准的成本降低一半。







Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of external sources, including Recursion 2024, , Paul et al. 2010, Schreiber 2022, and Dreiman 2021, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

药物开发成本可能会急剧下降

基础生物学，人工智能，自动化和试验设计的进步应显着降低临床前药物开发成本。它们能够在药物开发过程的早期消除不太有希望的候选药物，防止下游研发资本的错误分配，并在发现阶段的早期创造更大的化学搜索空间。在接下来的十年中，充分利用这些技术的公司可以将每次批准的成本降低近50%，部分原因是进入临床试验的候选药物的成功几率增加了一倍以上。

效率创新

创新试验设计

+ 适应性临床试验设计
+ 精密生物标志物
+ 分散/虚拟试验

基础生物学

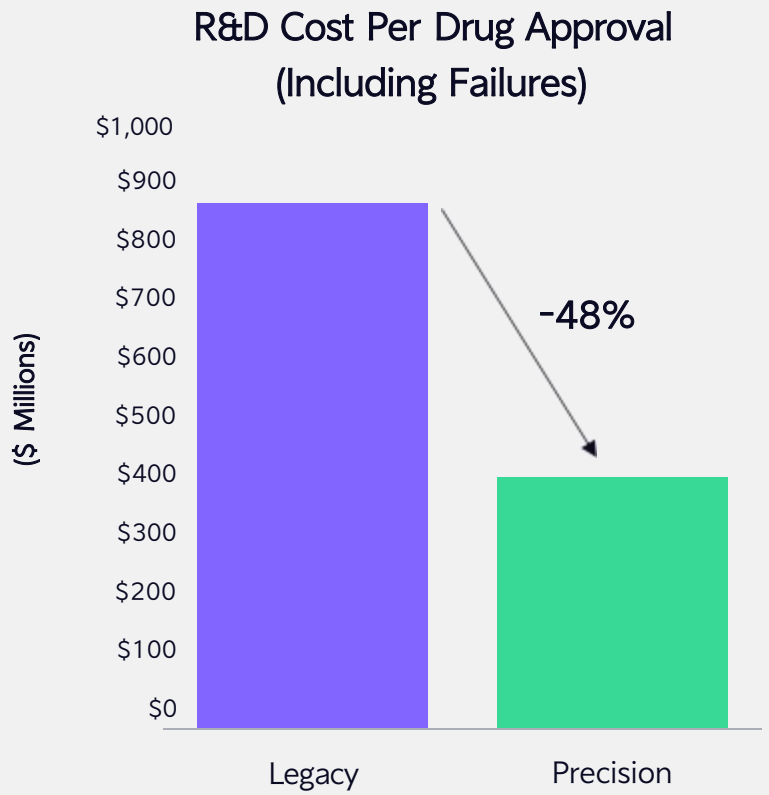
+ 单细胞生物学
+ 技术蛋白质组学
+ 虚拟复合库
+ 生物标志物开发
+ 人性化动物模型

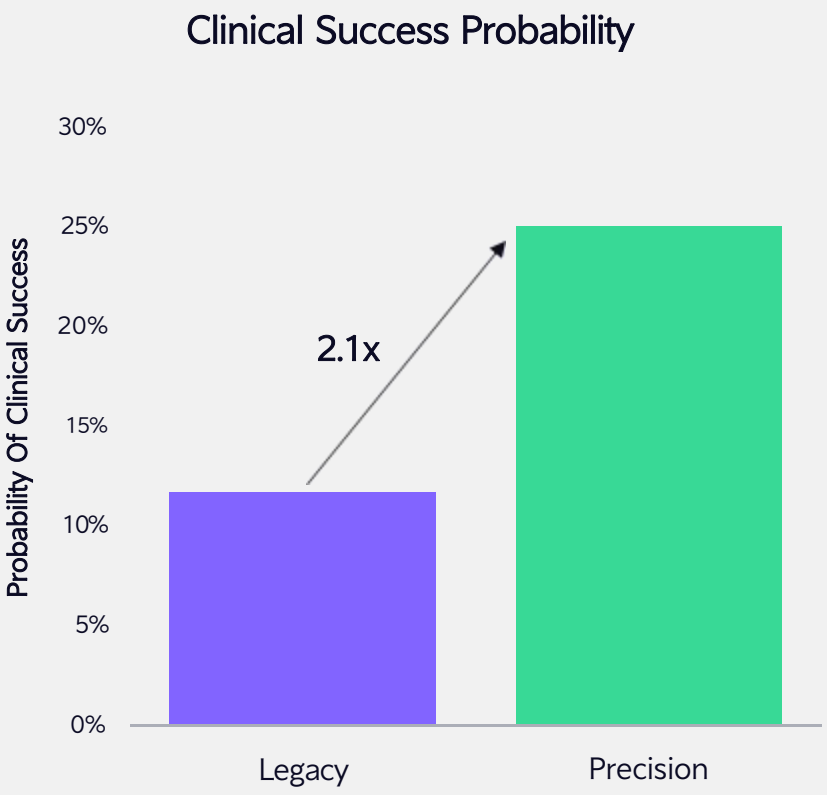
自动化

+ 自动液体处理
+ 自动Invivomics
+ 自动化微合成
+ CRISPR “Perturb-Seq” 屏幕
+ 器官芯片技术

人工智能

+ 支持AI的路径分析
+ AI支持的毒性预测
+ 计算机模拟分子
+ ML驱动的复合屏幕



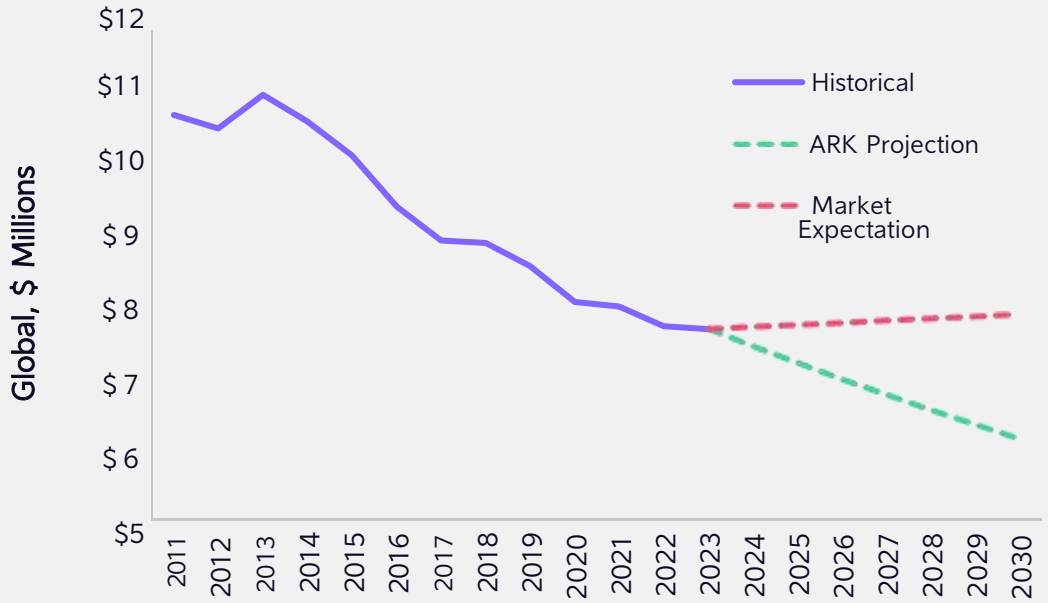


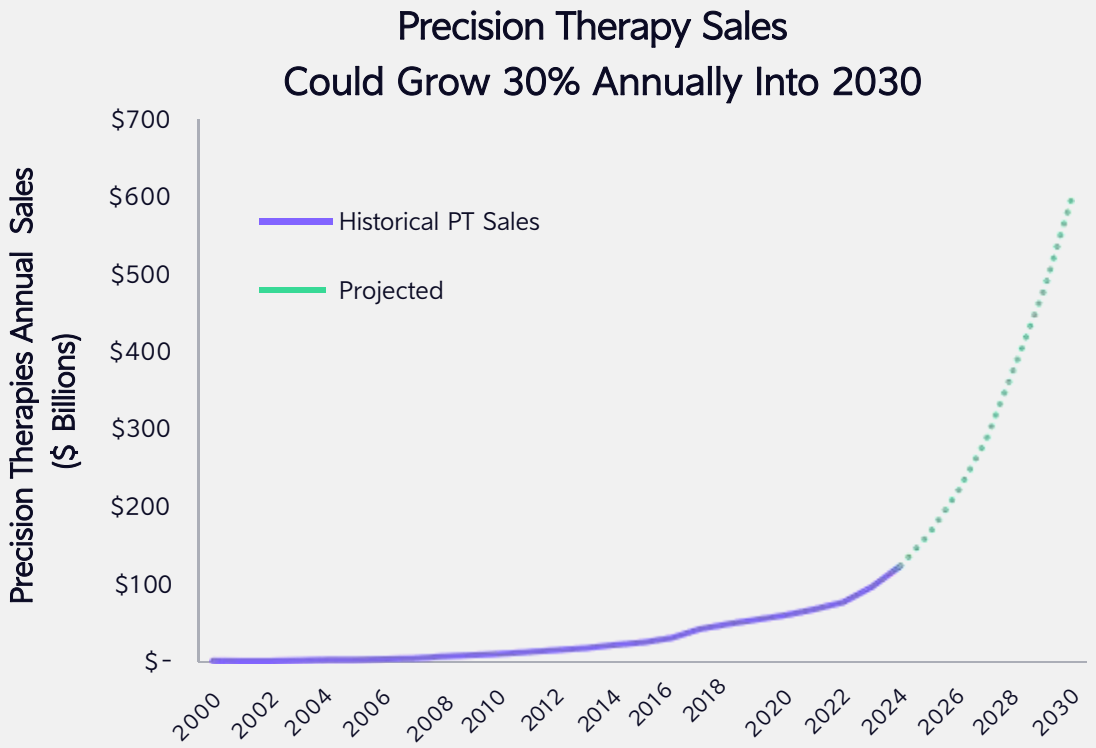
Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon.
For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

技术进步会降低每种药物的研发成本

在过去的十年中，每开发一种药物的研发支出以每年3% 的速度下降。根据我们的研究，由于基础生物学，单细胞测序，蛋白质组学，自动化和人工智能的突破性进展，这种下降应该会继续，如果不是加速的话。

到2030年，这些效率将为精准疗法的企业价值增加1.5万亿美元，即约40%。





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Research By:

Sam Korus
Director of Research, Autonomous Technology & Robotics

Daniel Maguire, ACA
Research Associate

电动汽车

较低的电池成本推动电动汽车的采用

Sources: ARK Investment Management LLC, 2024. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

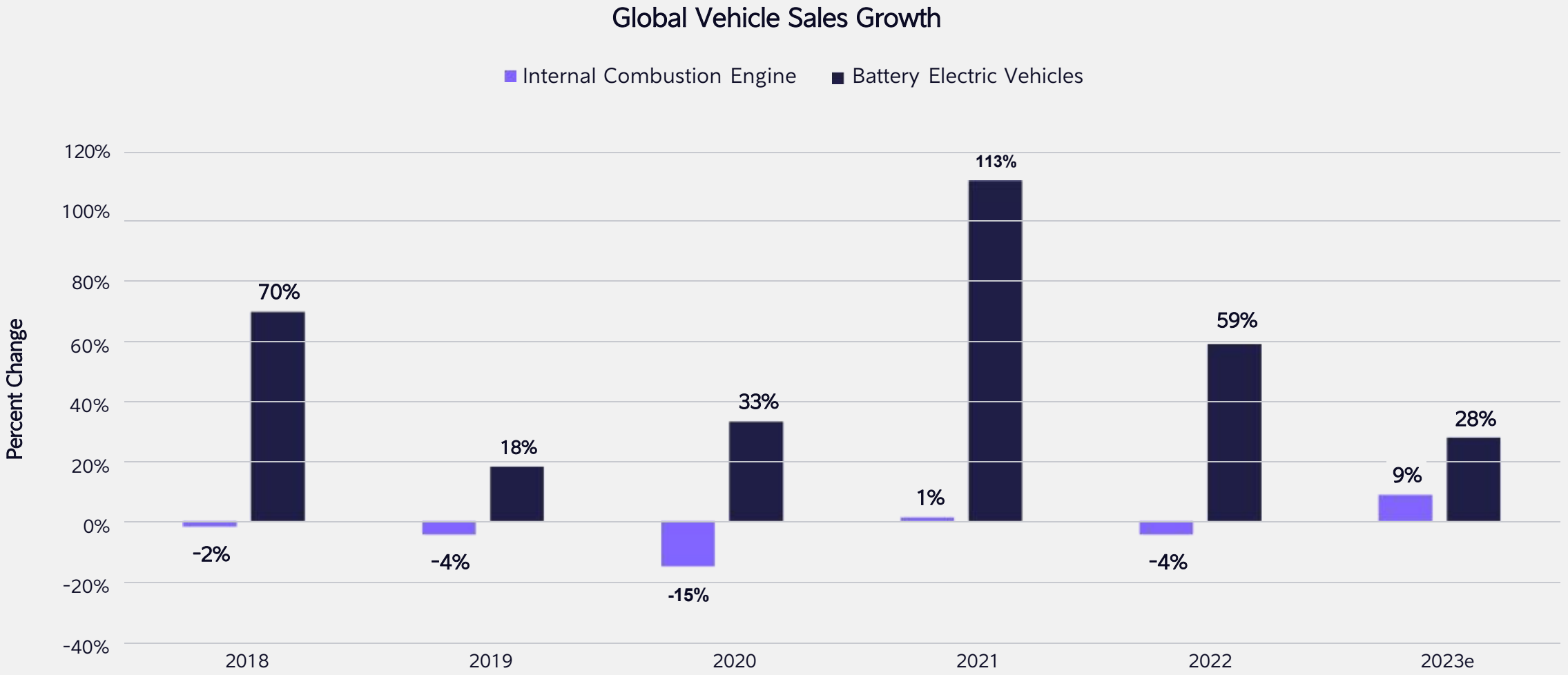
在应对供应链中断后，电池成本现在正在下降，符合赖特定律，导致电动汽车 (EV) 标价下降。

如果机器人出租车平台激增，到2030年，电动汽车将占汽车销量的95-100%。

ARK预测，未来七年电动汽车销量将以每年33% 的速度增长，从2023年的约1000万辆到2030年的7400万辆。

Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

电动汽车继续夺取内燃机汽车的份额



Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including EVVolumes.com, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

汽车行业可能会整合

如果电动汽车的采用继续获得牵引力，传统汽车制造商可能会被迫重组和整合。

通用汽车将密歇根州工厂的EV卡车生产推迟了一年

—Reuters Oct 17, 2023

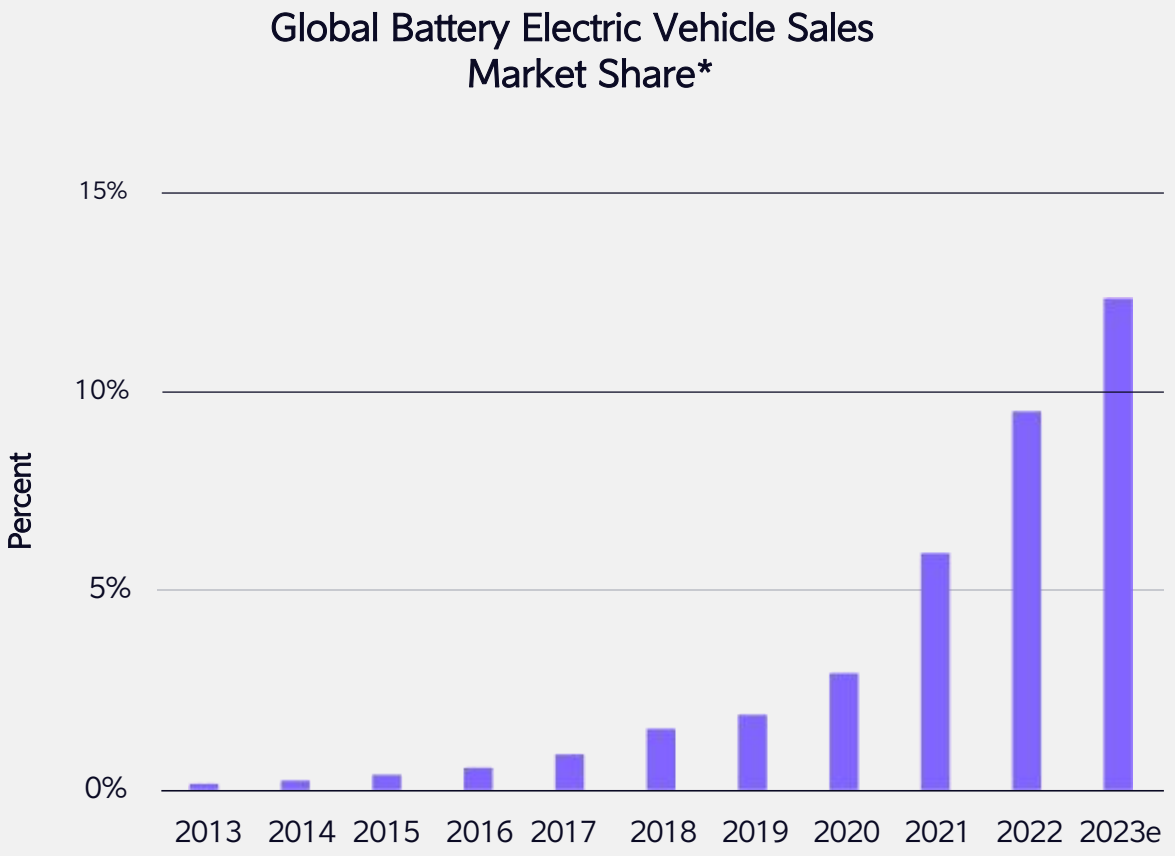
由于电动汽车需求“低迷”，大众集团推迟了在欧洲的电动汽车电池工厂。

“目前还没有商业理由来决定进一步的工厂，”大众集团首席执行官奥利弗·布鲁姆说。

—InsideEVs Nov 2, 2023

福特将削减每周F-150闪电的产量，以应对需求放缓

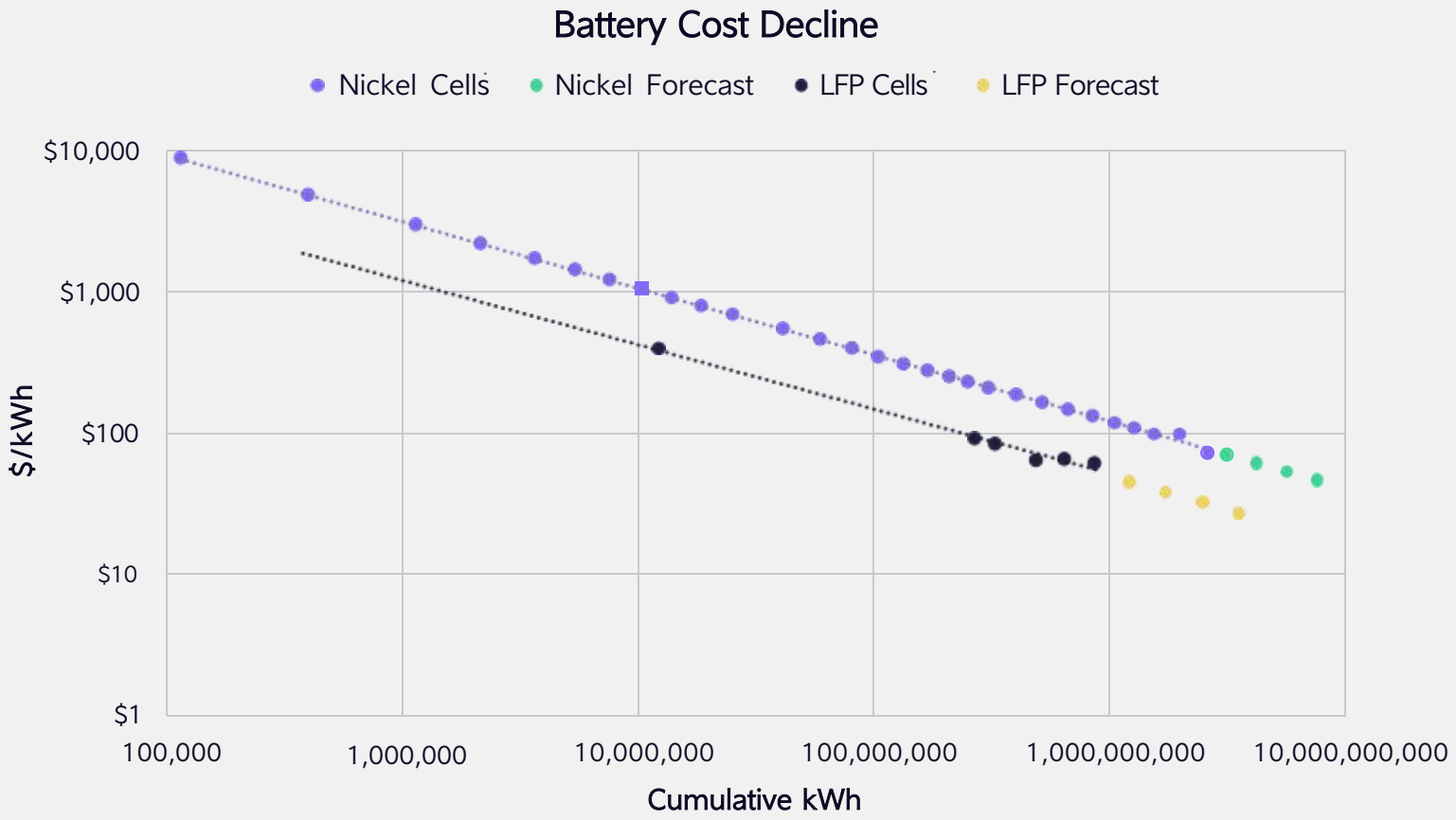
—The Verge Dec 11, 2023

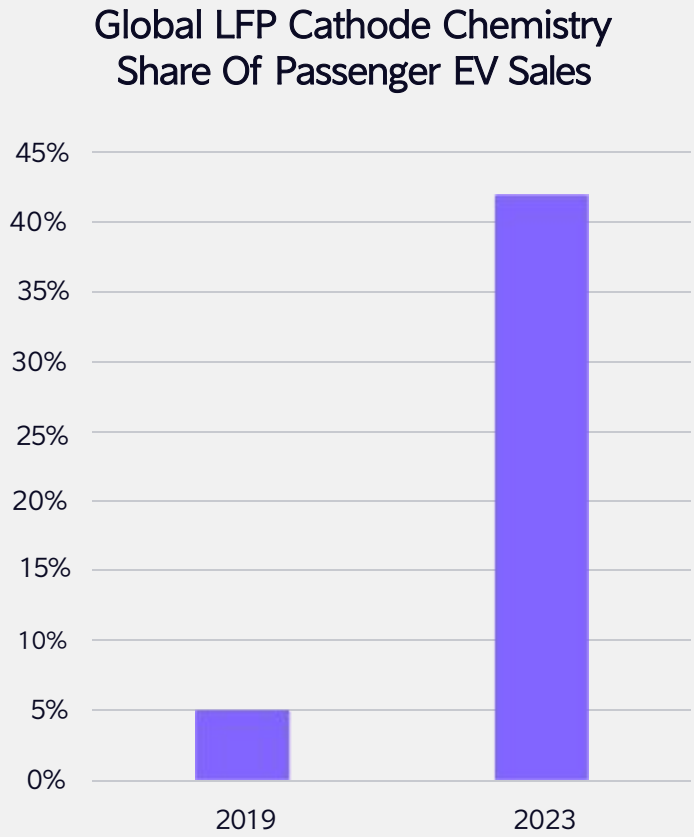


*BEV market share is calculated relative to all “light vehicles”, which are vehicles with a maximum Gross Vehicle Weight Rating (GVWR) of < 8,500 lbs. Sources: ARK Investment Management LLC, 2024, based on data from EVVolumes.com 2023, Hawkins 2023, Mihalascu 2023, Shepardson & Klayman 2023, Rosevear 2023, Transport Policy 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

赖特定律准确地模拟了电池成本的下降

根据赖特定律，生产的千瓦时数量每增加一倍，电池成本就会下降28%。磷酸铁锂 (LFP) 电池正在夺取镍电池的份额，这表明随着电池化学成分的变化，预测商品价格的难度很大。



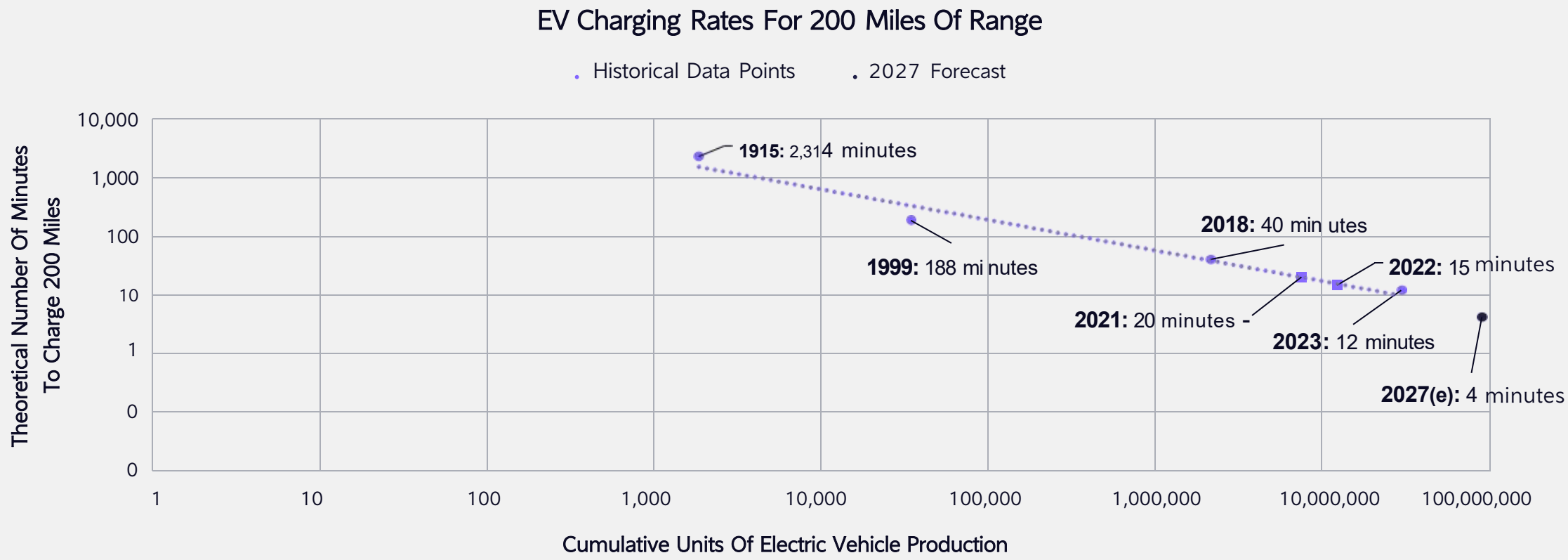


*Combination of modeled and historical data. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including Bloomberg New Energy Finance 2023, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

赖特定律指出电动汽车充电速度更快

EV充电率似乎是整体性能的良好代表，包括效率，续航里程和功率。在过去的五年里，200英里续航里程的充电速度提高了近三倍，从40分钟提高到12分钟，并可能在未来五年内再减少三倍至4分钟。

随着电动汽车充电达到可接受的费率，制造商可能会优化其他功能，包括自动驾驶、安全和娱乐。

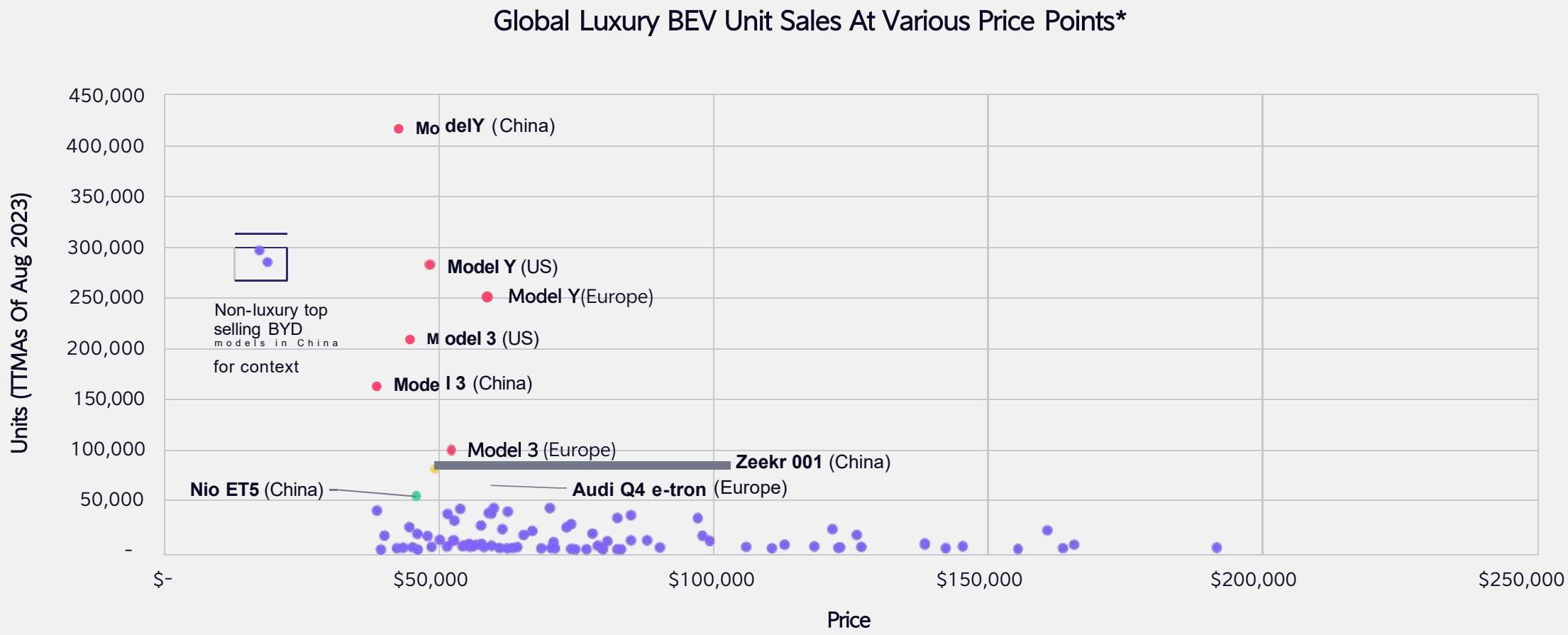


Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Big Ideas 2024—智能小巨人科技编译版

许多电动汽车制造商正在努力扩大规模以实现盈利

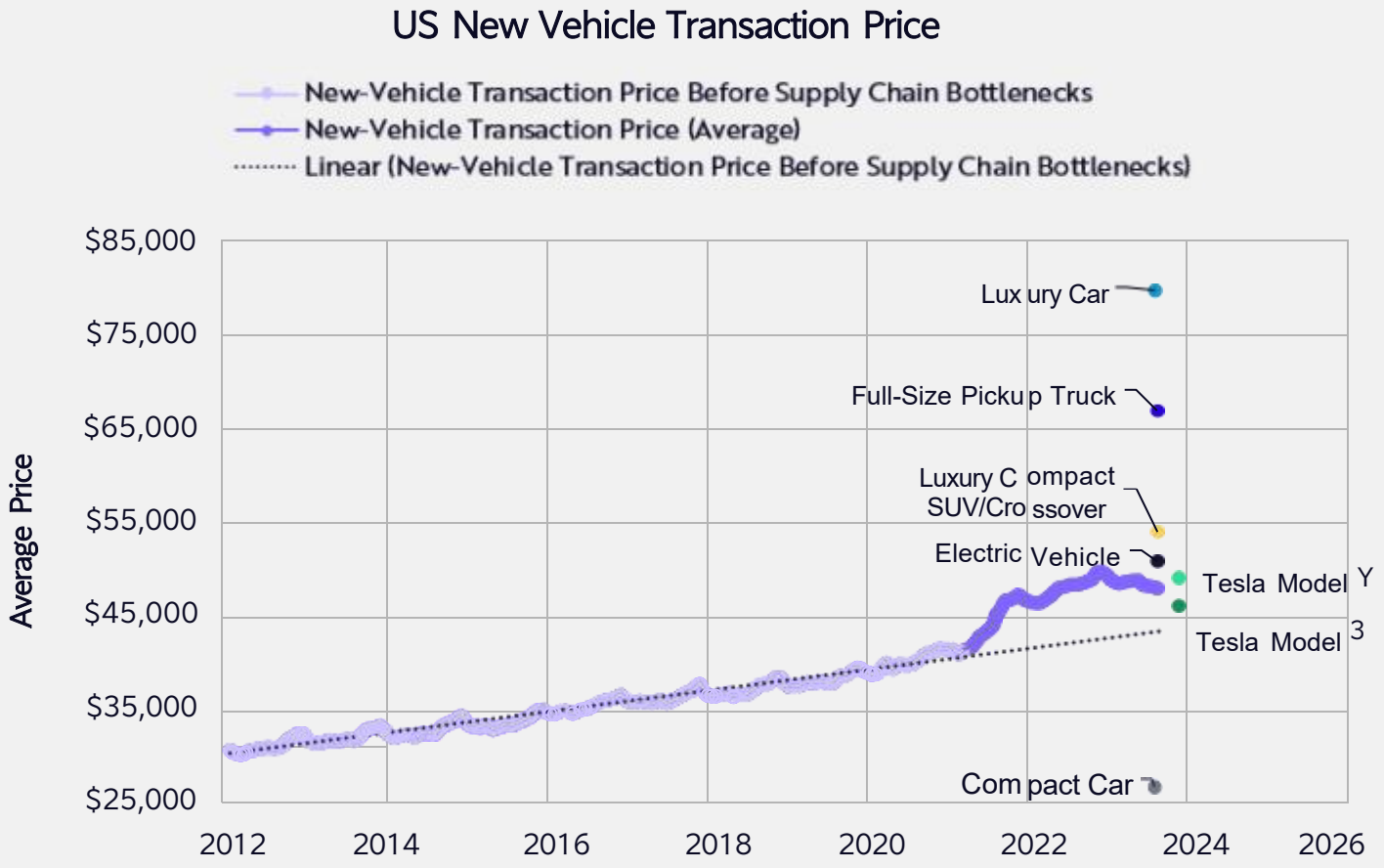
在没有电动汽车供应链的情况下，特斯拉别无选择，只能进行垂直整合。现在供应链正在发展，其他汽车制造商如果扩大规模，将实现盈利。然而，许多人正在退出市场，因为已经盈利的市场领导者正在积极降价。

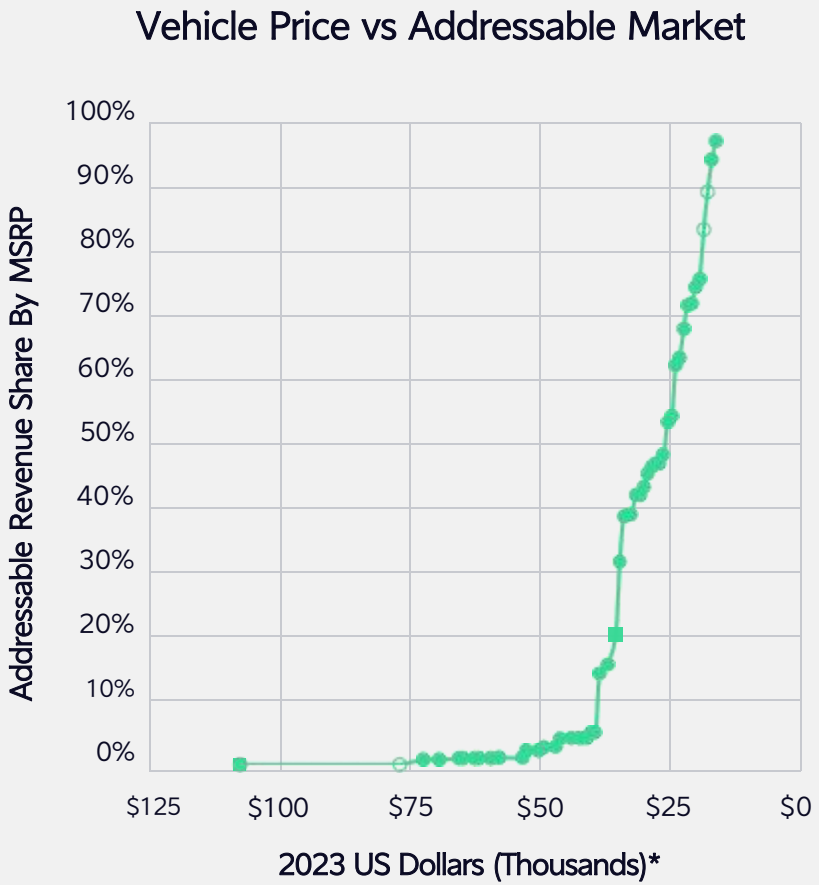


*Data may not be exhaustive. "TTM" (trailing twelve months). "BEV" (battery electric vehicle). Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including Piper Sandler 2023, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

电动汽车与内燃机汽车的价格持平

随着电池成本的持续下降，电动汽车的价格应该会下降，这可能会推动单位销量的指数增长。

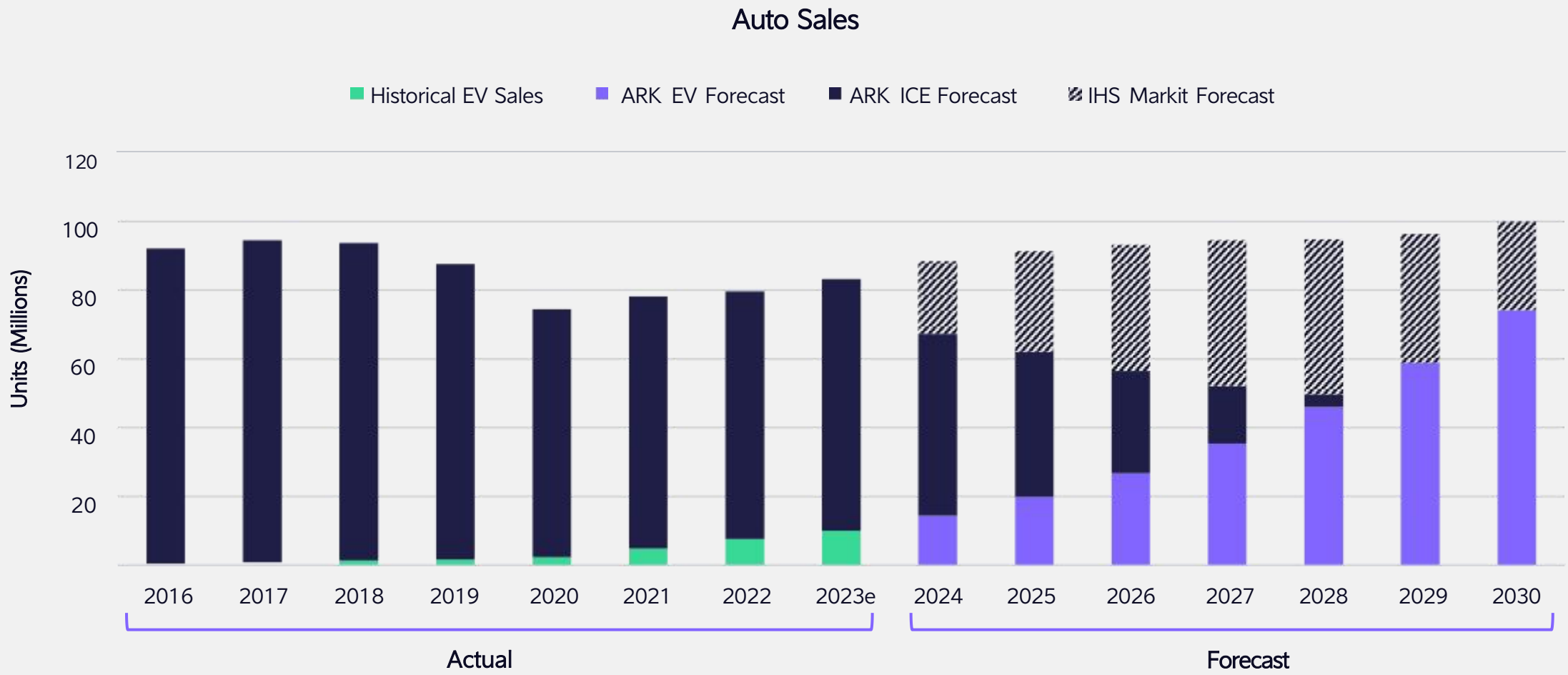




*Older data points adjusted to 2023 dollars using CPI. Segment average transaction prices are as of September 2023 as reported by Cox Automotive. Tesla Model Y LR price taken from Tesla website as of December 2023. Sources: ARK Investment Management LLC, 2024, based on data from Cox Automotive 2023.. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

内燃机汽车将失去重要的份额

如果电动汽车继续获得份额，就像我们相信的那样，那么二手车和新型电动汽车将比新型内燃机 (ICE) 汽车更具经济意义，也许会导致现有汽车制造商的死亡螺旋。随着电动汽车和二手车价格的下跌，消费者可能会推迟购买，等待更低的价格点。



Note: Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Research By:

Sam Korus
Director of Research, Autonomous Technology & Robotics

Daniel Maguire, ACA
Research Associate

机器人

AI软件和硬件的融合实现自动化

Sources: ARK Investment Management LLC, 2024. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

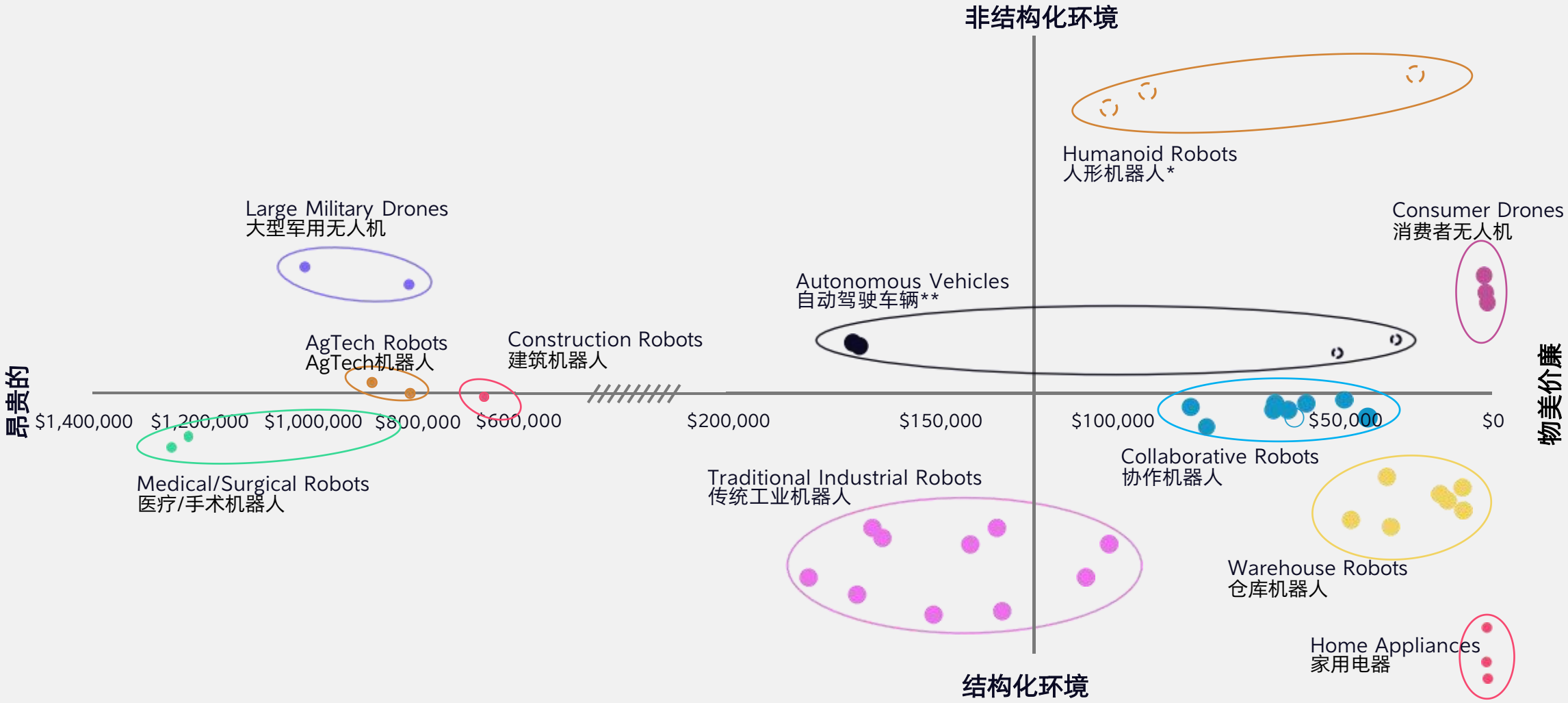
人工智能和硬件的融合应该能够实现可推广的机器人技术。

机器人在工厂环境中的表现优于人类，能够在许多领域做到这一点。

根据赖特定律，随着硬件和软件成本的下降，人工智能将会继续提高生产力，并为通用机器人创造新的市场机会，每年的收入超过24万亿美元。

Wright’s Law states that for every cumulative doubling of units produced, costs will fall by a constant percentage. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

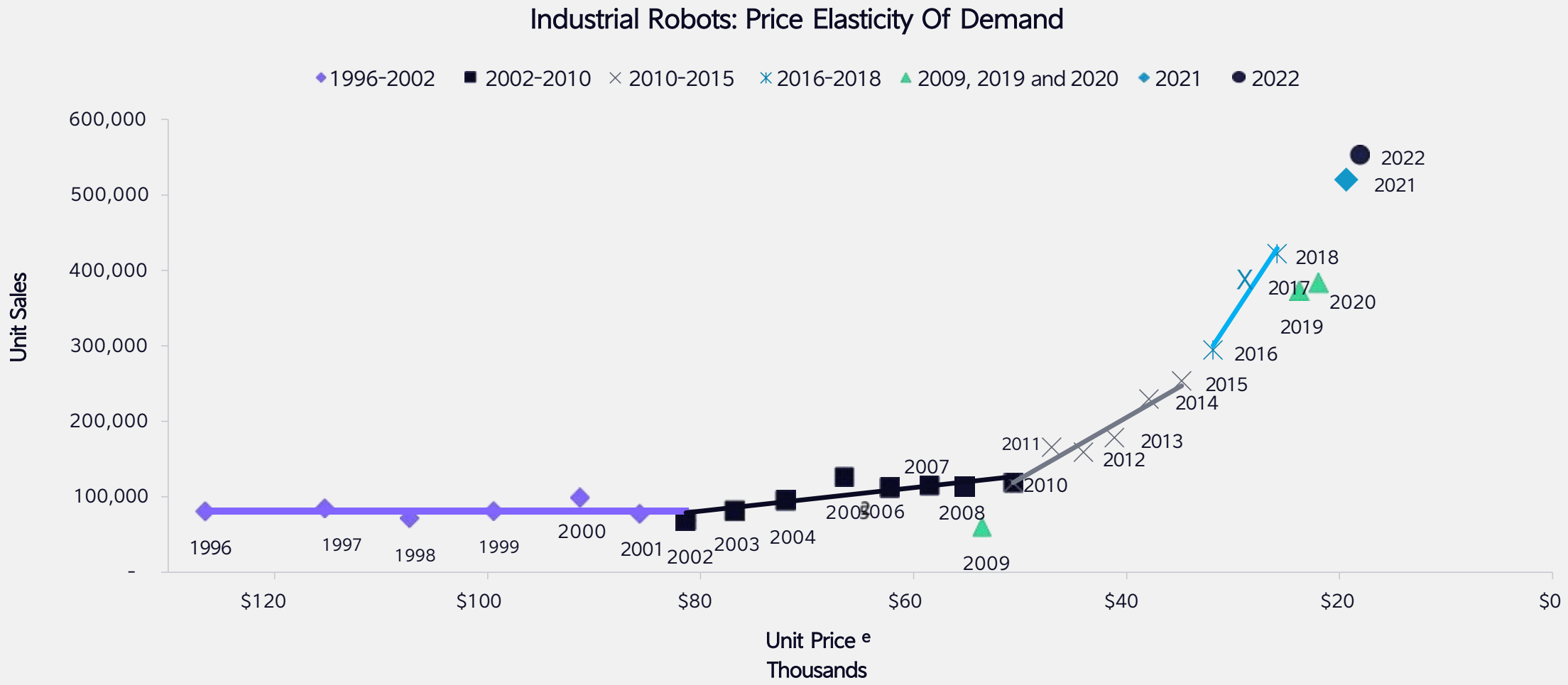
受益于人工智能和计算机视觉，机器人将能够在非结构化环境中经济高效地运行



The points in each category represent real world products with the exception of humanoid robots and autonomous vehicles *These figures are estimated costs of humanoid robots that we expect to hit the market. **These figures are for both current operating and future robotaxis. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

较低的价格刺激了对工业机器人的需求

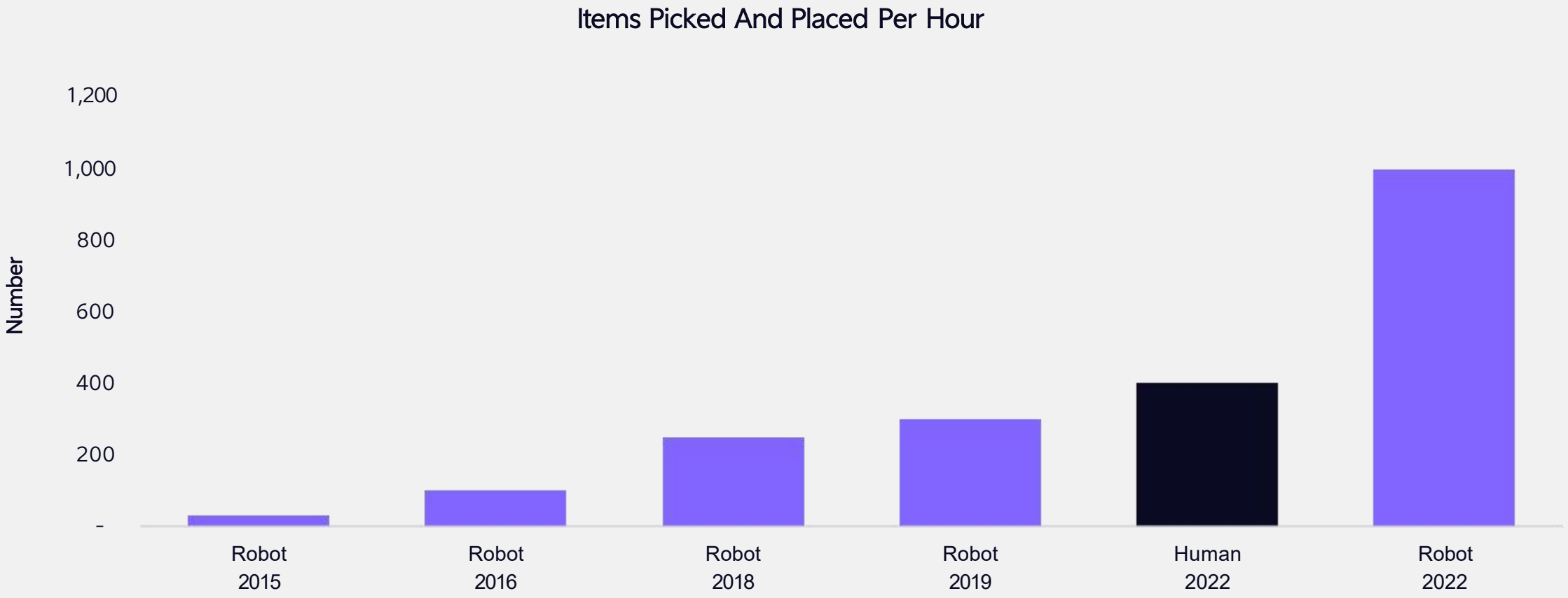
工业机器人的成本随着产量每增加一倍就会下降50%。



Sources: ARK Investment Management LLC, 2024, based on data from The International Federation of Robotics 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

性能的提高刺激了对工业机器人的需求

计算机视觉和深度学习的进步使机器人性能在七年内提高了33倍。机器人的表现已经超过了人类的两倍，目前还不清楚上限在哪里。

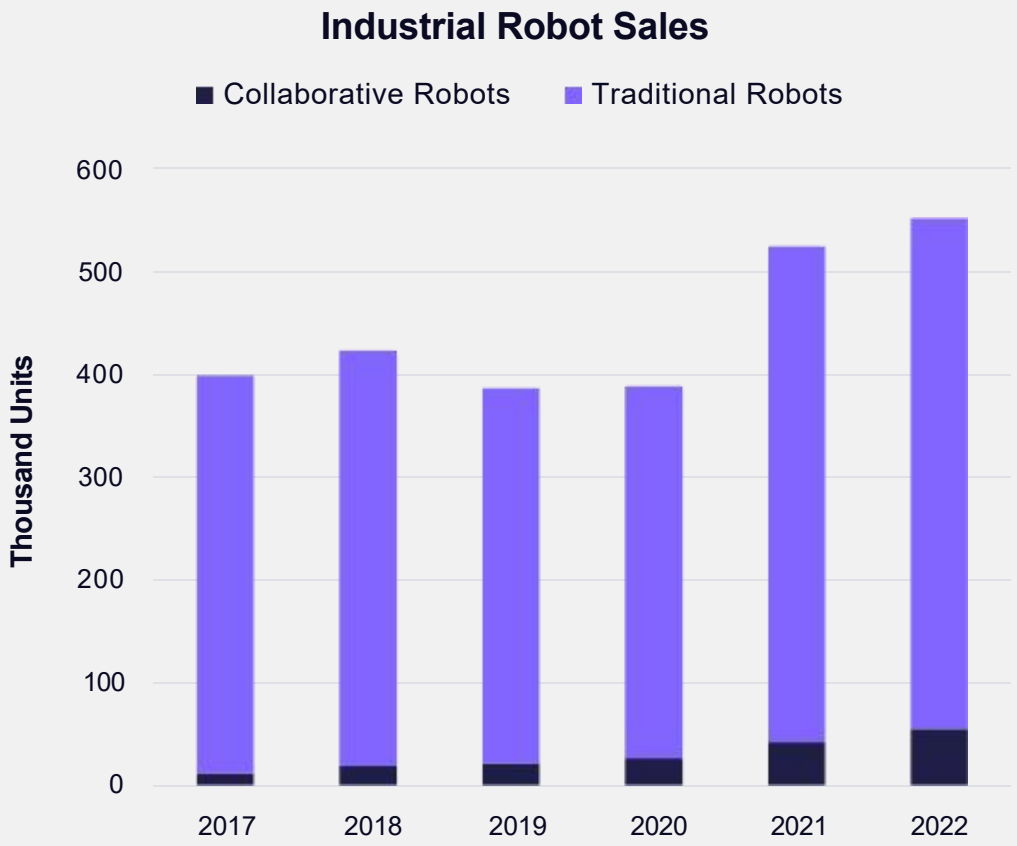


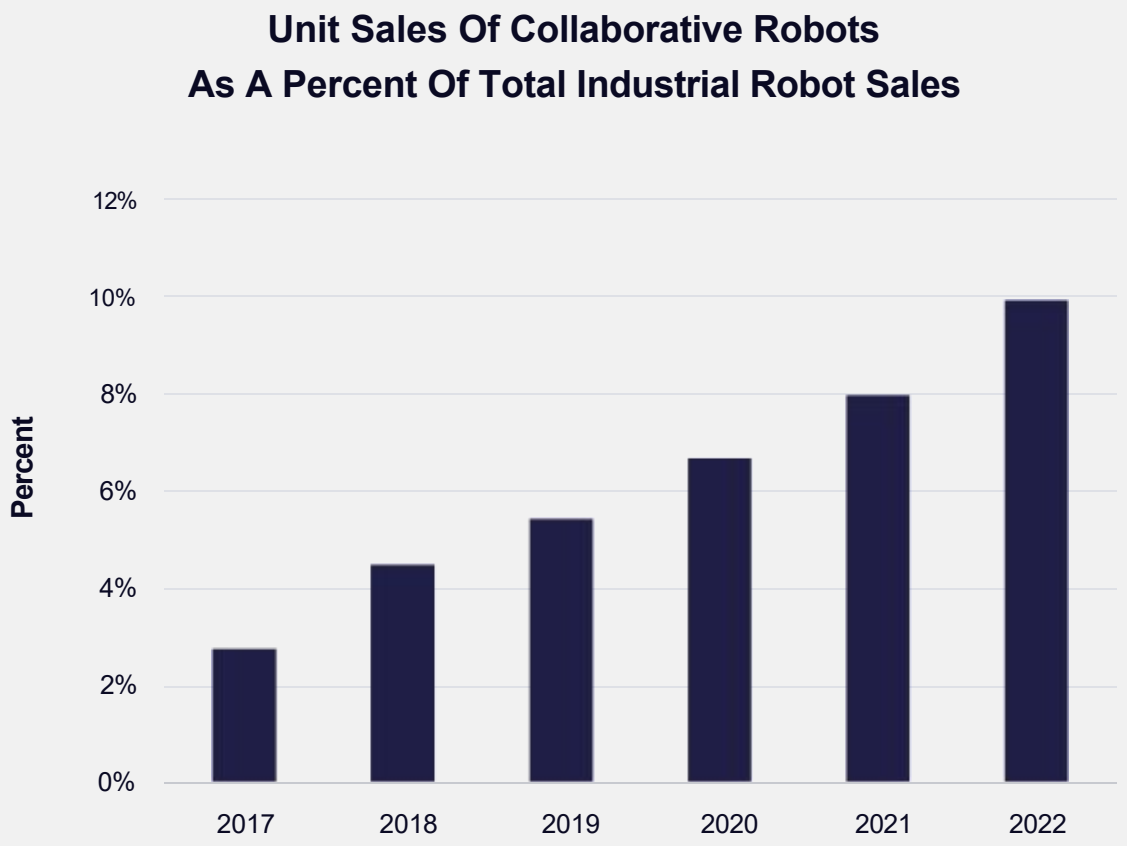
Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Big Ideas 2024—智能小巨人科技编译版

协作机器人正处于采用曲线的最佳位置

协作机器人和人类可能会一起工作，无论是在路上，在工厂还是在家里。从历史上看，当新技术的采用接近10-20%的市场份额时，S曲线达到临界点。*

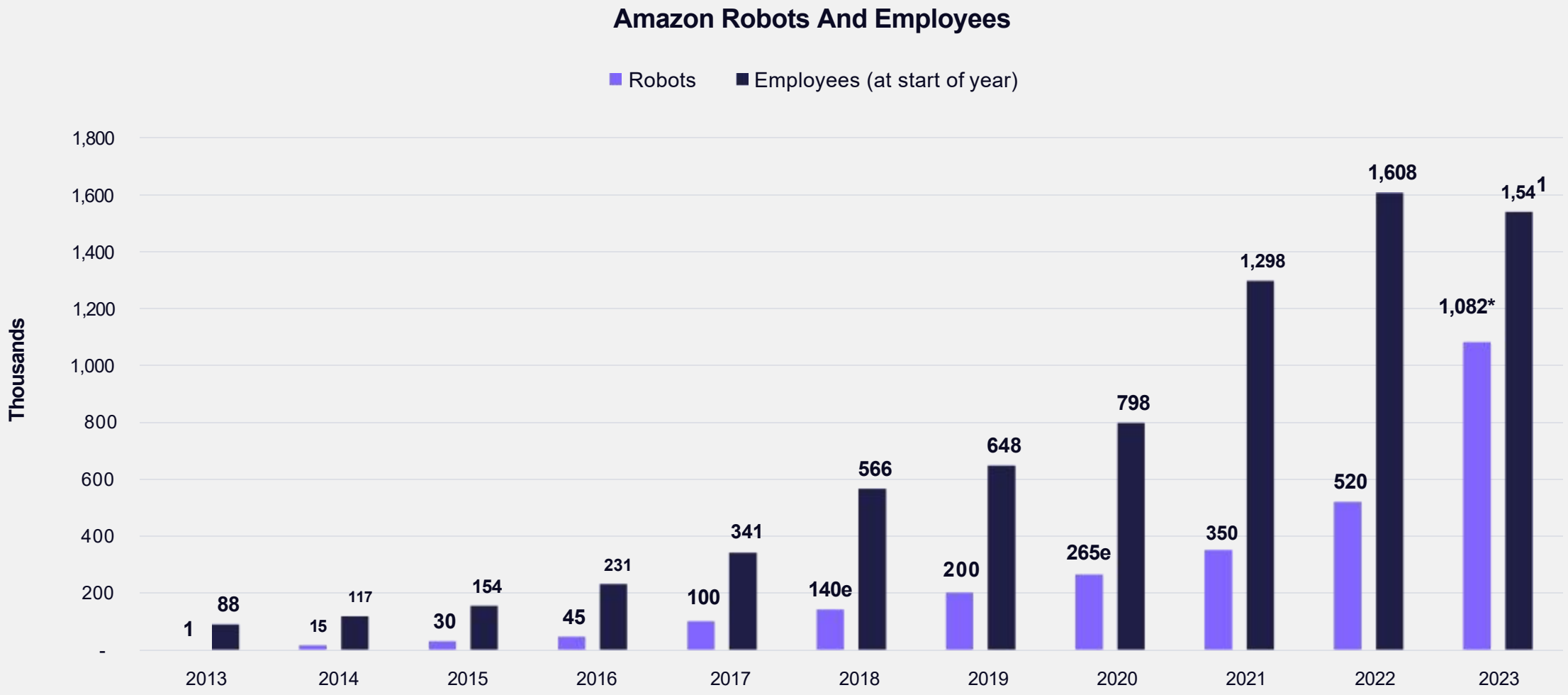




*S-Curve refers to the typical technology adoption curve, which looks like an "S" when plotted over time. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including International Federation of Robotics 2023 and Citi Research 2023, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

许多公司可能会部署比人类更多的机器人

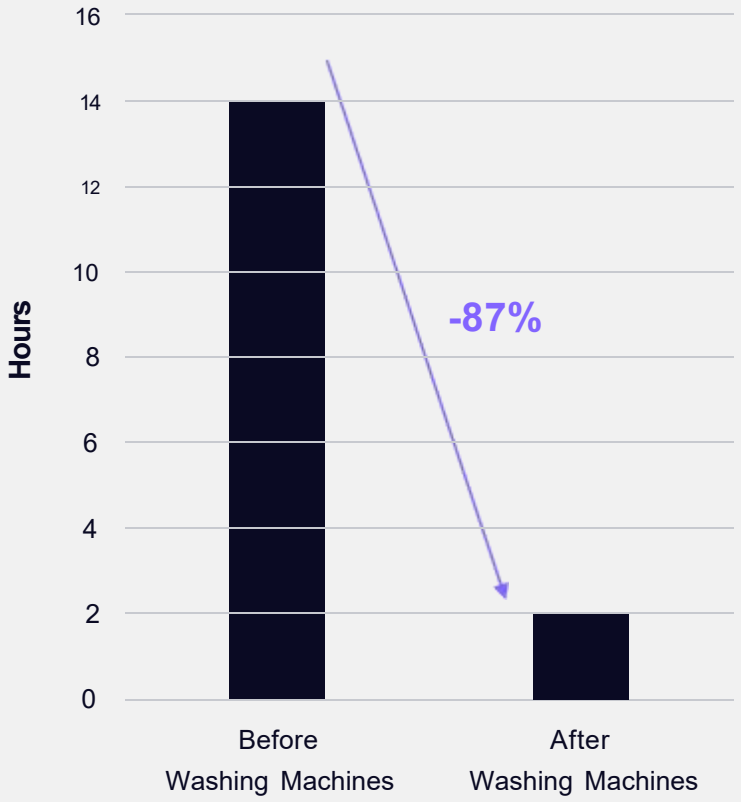
机器人正在将人类从繁琐的体力任务中解放出来。



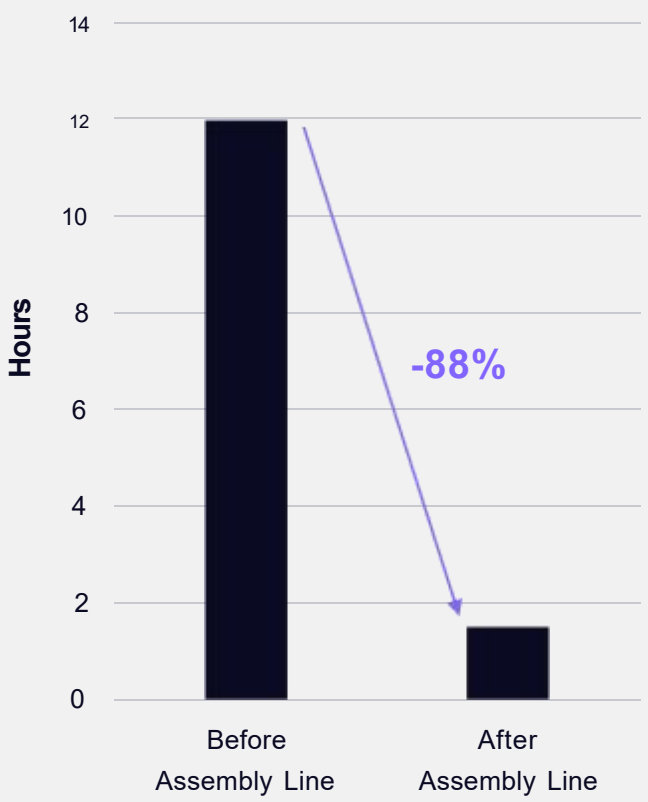
*Modeled/annualized. Figures denoted with an “e” are ARK estimates. Sources: ARK Investment Management LLC, based on data from Amazon 2023 as of June 26, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

自动化对生产力的影响已经改变了行业

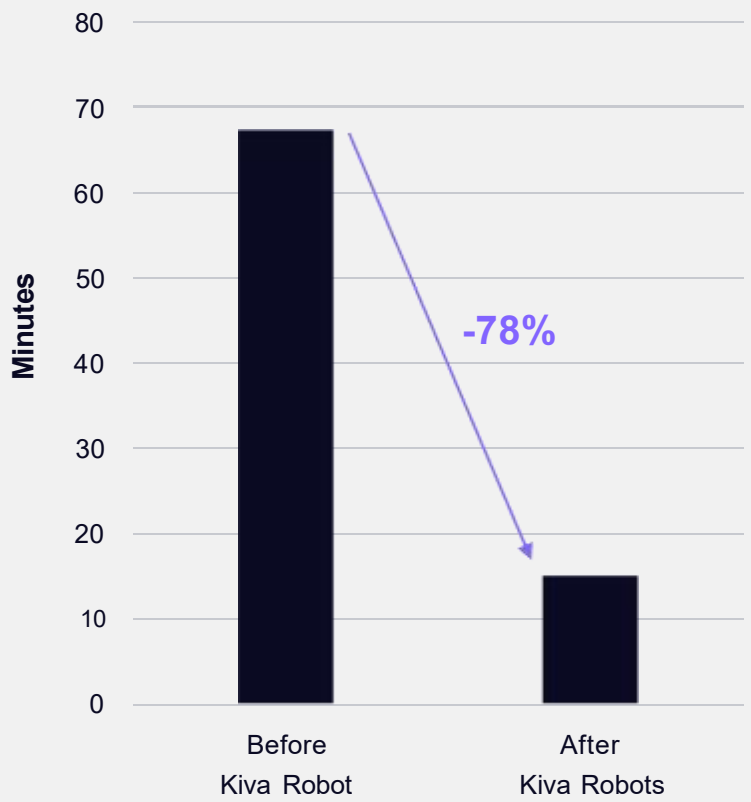
Time To Do Laundry



Time To Manufacture A Car



Time From Click To Ship At An Amazon Warehouse



Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

可推广的机器人技术代表着潜在的24万亿美元的全球收入机会

家用机器人
Household Robotics

~2.3每天无偿工作小时数

*

~28亿劳动年龄人口

*

~10.75美元加权平均小时工资

*

½ 价值来自于空闲时间与付费时间

=

~12.5万亿美元机会

制造机器人
Manufacturing Robotics

ARK预测2030年全球制造业GDP约为28.5万亿美元

		Productivity Uplift					
		10%	25%	50%	100%	200%	400%
Take Rate	10%	286	714	1,429	2,857	5,715	11,430
	20%	571	1,429	2,857	5,715	11,430	22,860
	50%	1,429	3,572	7,144	14,287	28,575	57,149

Revenue Opportunity*
(Billions)

=

~超过12万亿美元机会
(绿色方块平均值)

*Note: the cells highlighted in green represent what ARK believes to be a reasonable or likely outcome. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Research By:
Tasha Keeney, CFA
Director of Investment Analysis & Institutional Strategies
Daniel Maguire, ACA
Research Associate

无人驾驶出租车

安全经济地改造城市交通

Sources: ARK Investment Management LLC, 2024. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

由于人工智能的突破，无人驾驶的机器人出租车开始彻底改变城市出行，并可能加速汽车贷款行业的瓦解。

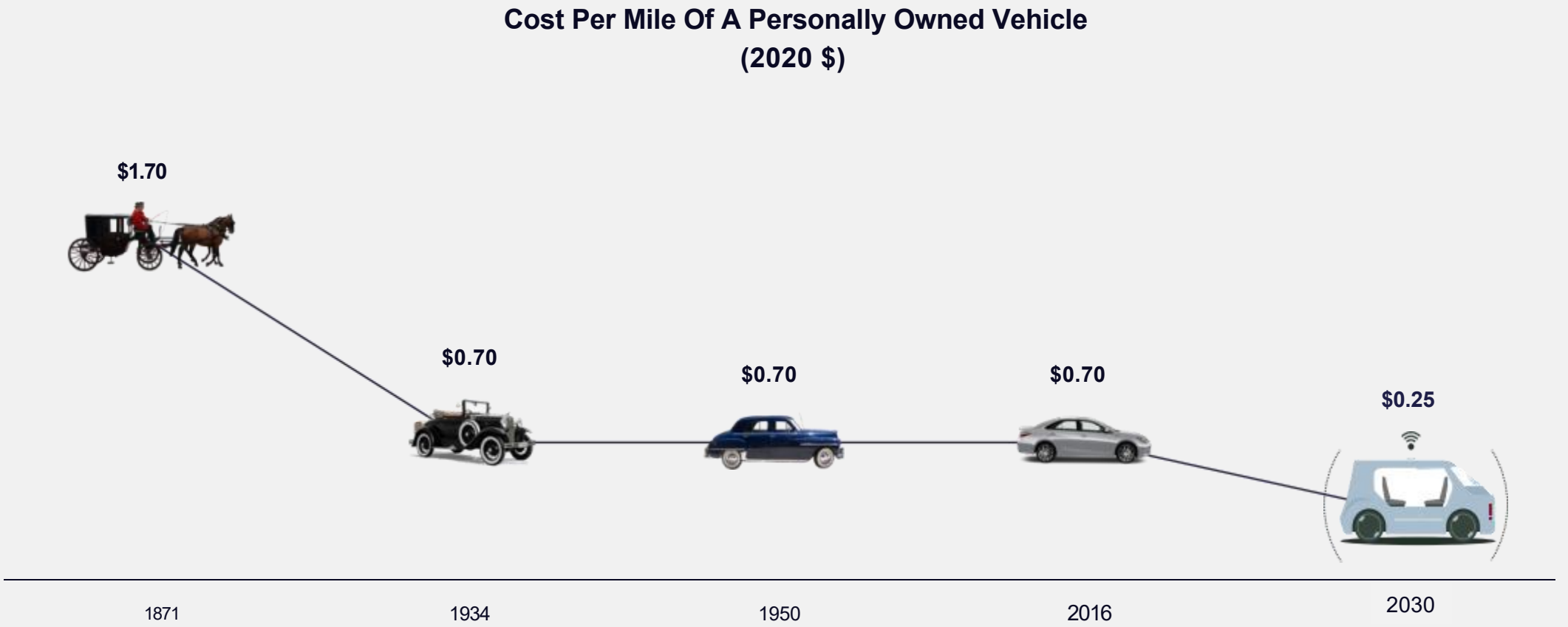
比人类司机更安全，无人驾驶出租车承诺更安全，更清洁的街道。无人驾驶出租车平台的先驱应该享受与早期采用相关的更高价格。

根据ARK的研究，无人驾驶出租车平台可以重新定义个人移动交通，并在未来五到十年内产生28万亿美元的企业价值。

Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

自动驾驶可能会带来便捷的点对点交通

经过通货膨胀调整后，自100多年前T型车下线以来，拥有和运营私家车的成本并没有改变。ARK估计，大规模的自动驾驶出租车每英里的成本可能仅为0.25美元，从而刺激了广泛的采用。



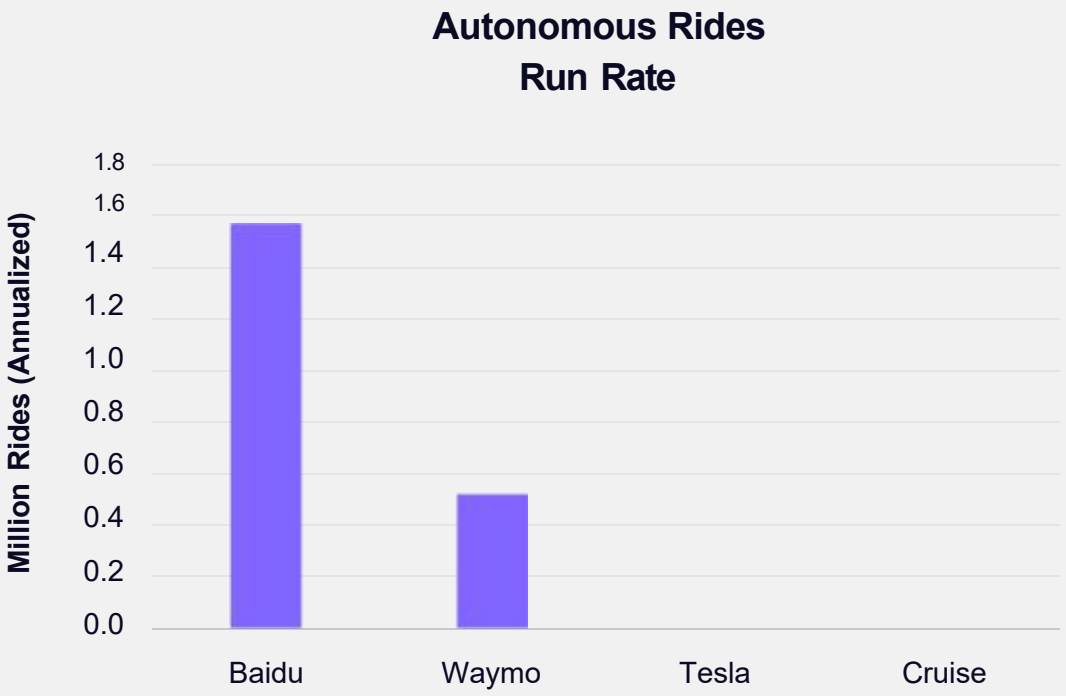
Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

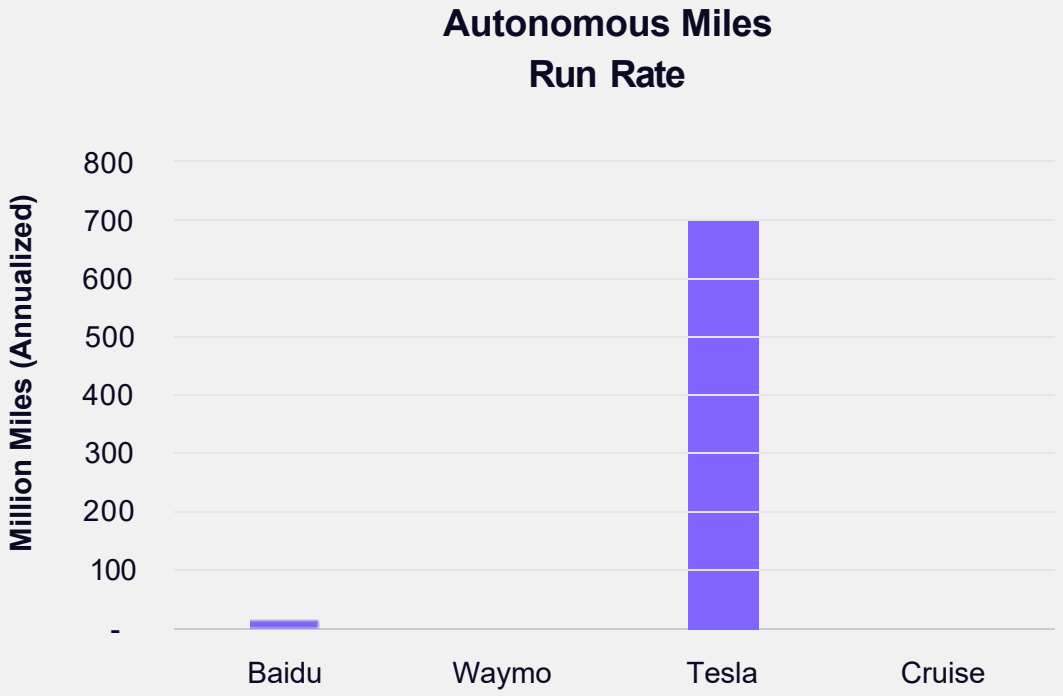
Big Ideas 2024—智能小巨人科技编译版

去年年底，无人驾驶出租车年化乘客出行率约为2000万

无人驾驶出租车在全球约20个城市运营，至少在7个城市拥有完全无人驾驶的商业选择。2023年，百度的运营速度为160万次自动驾驶，是Waymo的3倍。Cruise已停止在美国的业务。

特斯拉获得的驾驶数据是百度的50倍，是Waymo的280倍，在准备推出全球最大的人工智能无人驾驶出租车服务时，特斯拉拥有巨大的数据优势。



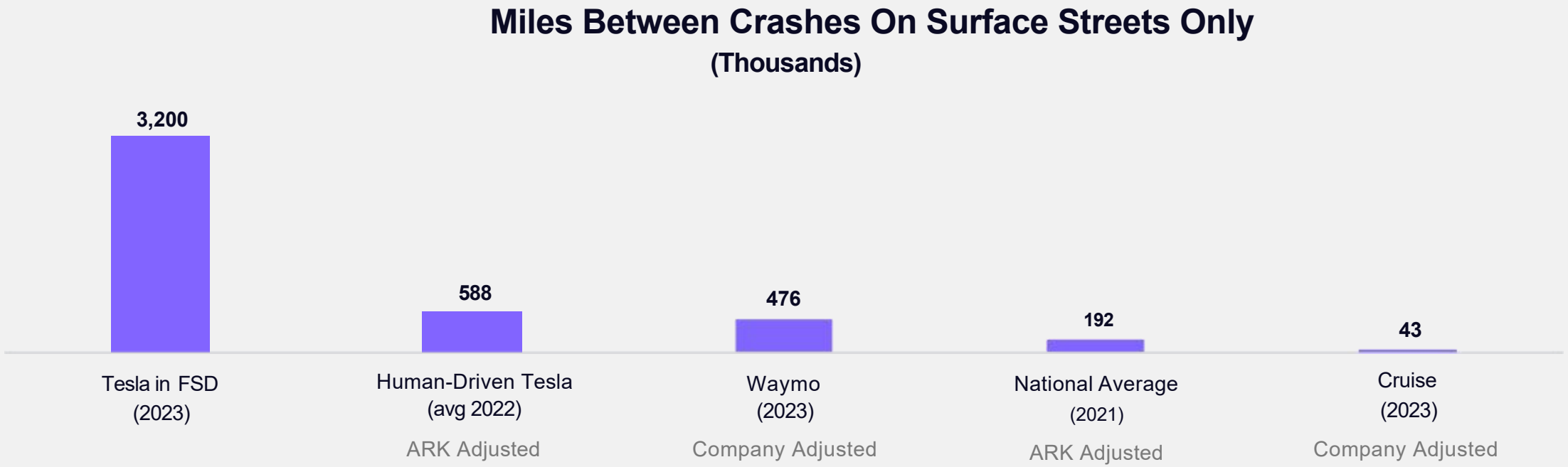


*This includes only the 55% of rides that are fully autonomous at Baidu. The chart on the right assumes 5 miles per trip for Waymo, Cruise, and Baidu. Tesla miles in righthand chart are FSD miles and still require a human behind the wheel. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

自动驾驶车辆比人类驾驶车辆更安全

2015年，ARK估计自动驾驶汽车的事故率将比人类驾驶员低约80%。在美国，每年减少约40,000例与汽车相关的死亡事故，而在全球，每年减少约135万。目前的数据支持我们最初的估计。

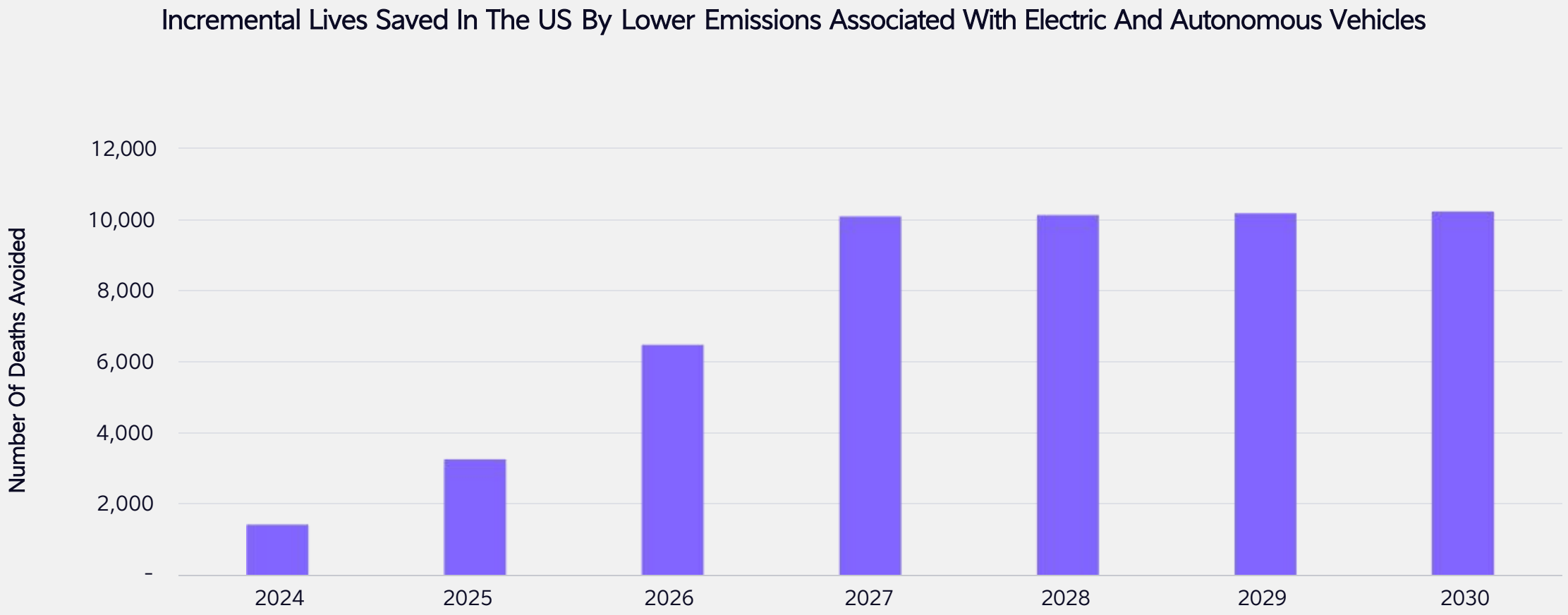
在地面街道上的全自动驾驶 (FSD) 模式下，特斯拉似乎比手动模式下的特斯拉安全约5倍，比全国平均水平安全约16倍。Waymo的自动驾驶汽车比全国平均水平安全2-3倍，而Cruise——现在被监管机构搁置——似乎远远低于全国平均水平。



Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including CDC 2024, Kusano 2023, NHTSA 2023, Tesla 2023, 2024, and Zhang, 2023, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

自动电动交通每年会挽救约10,000名因汽车排放而丧生的美国人

在美国，汽油动力乘用车造成的空气污染每年导致9,700人死亡。根据ARK的研究，自动驾驶电动汽车将在2030年让约10,000人免于死亡。



*This analysis is based on ARK’ s autonomous electric vehicle adoption forecast and adjusted for population growth. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including Thakrar et al. 2020, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

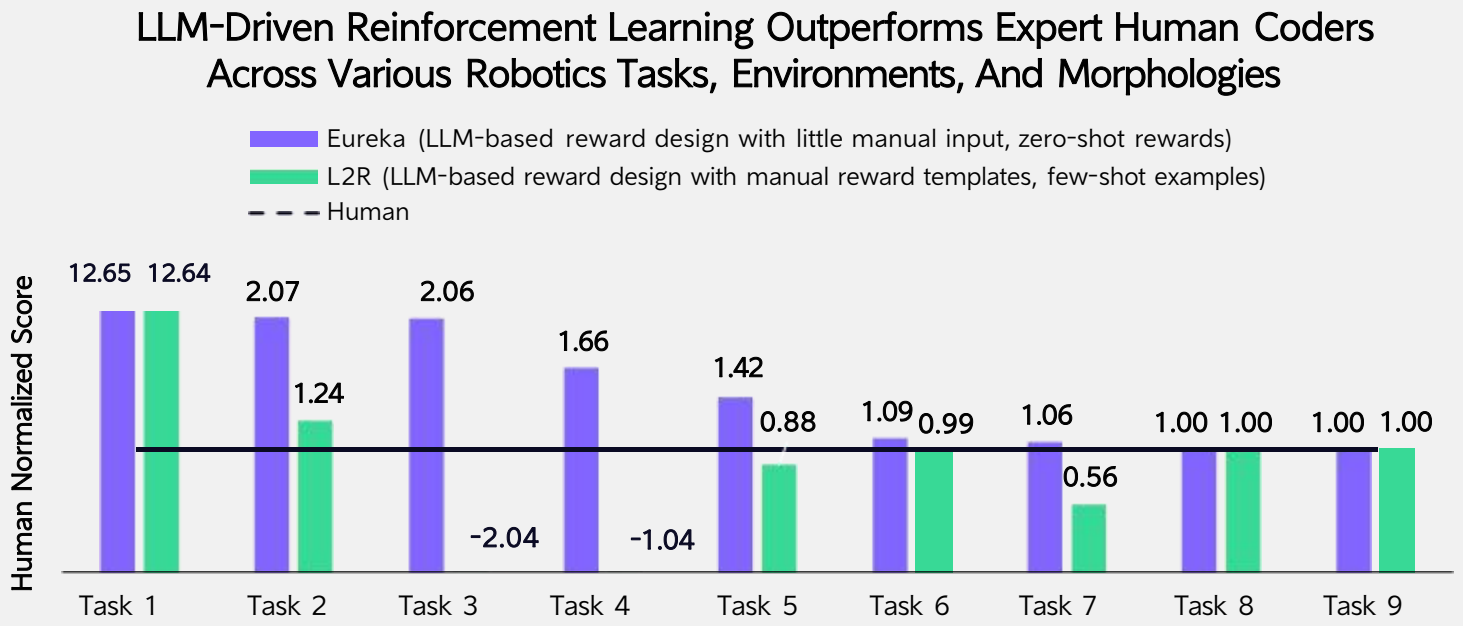
Big Ideas 2024—智能小巨人科技编译版

大型语言模型和生成式AI加速了机器人技术的进步

经过GPT-4训练以执行机器人任务，神经网络在83%的任务上表现优于专业的编程人员，平均改善幅度为52%。

大型语言模型 (LLM) 支持基于文本的训练、验证和自我解释，这应该有助于监管部门的批准。多模态模型可以用图像和文本训练自动驾驶汽车，这可能会带来更好的性能。

生成式AI可以通过仿真训练和验证自动驾驶汽车的安全性。



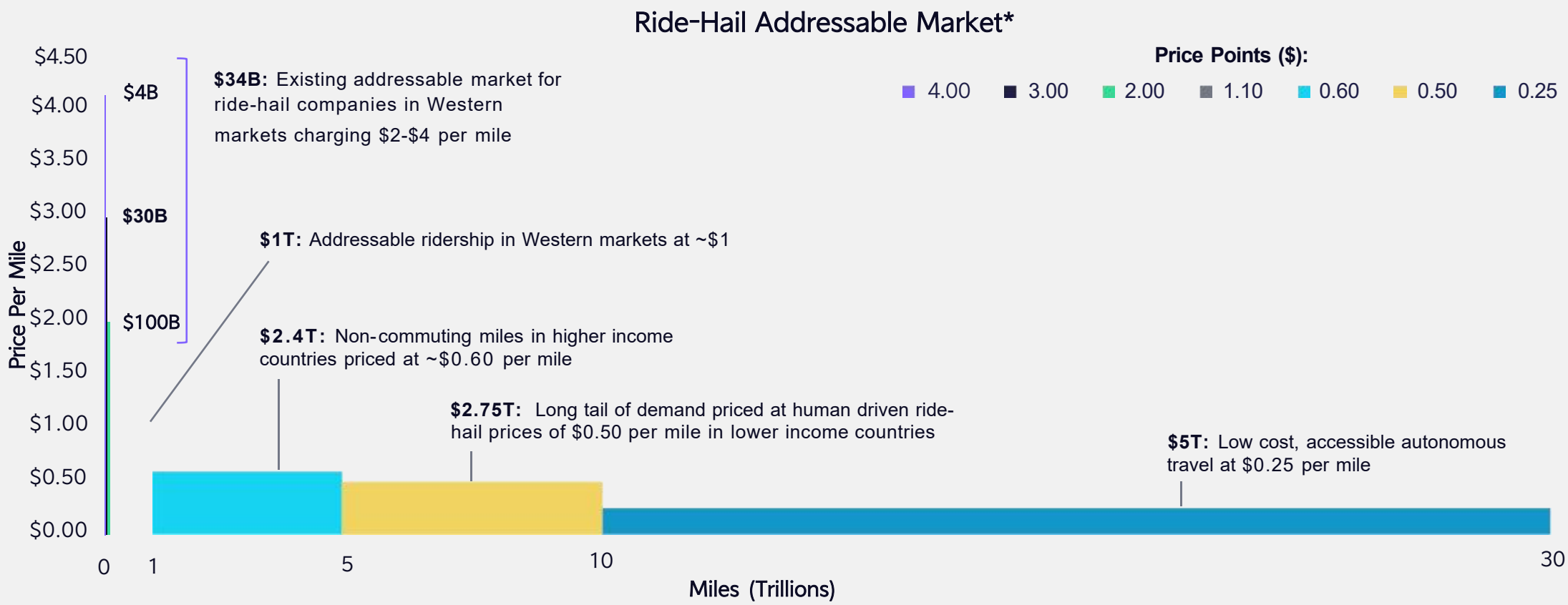
Task Legend:

Task 1: To open the cabinet door
Task 2: To make the hand spin the object toward a target.
Task 3: To make the humanoid run as fast as possible.
Task 4: To make the ant run forward as fast as possible.
Task 5: To make the shadow hand spin the object toward a target.
Task 6: To make the quadruped follow randomly chosen x, y and yaw target velocities.
Task 7: To make the quadcopter reach and hover near a fixed position.
Task 8: To balance a pole upright on a cart.
Task 9: To stabilize a ball on the table-top.

Note: Yaw is rotation along the vertical axis of an aircraft. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including Ma et al. 2023 and Wayve 2023, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

无人驾驶网约车可能会创造一个11万亿美元的潜在市场

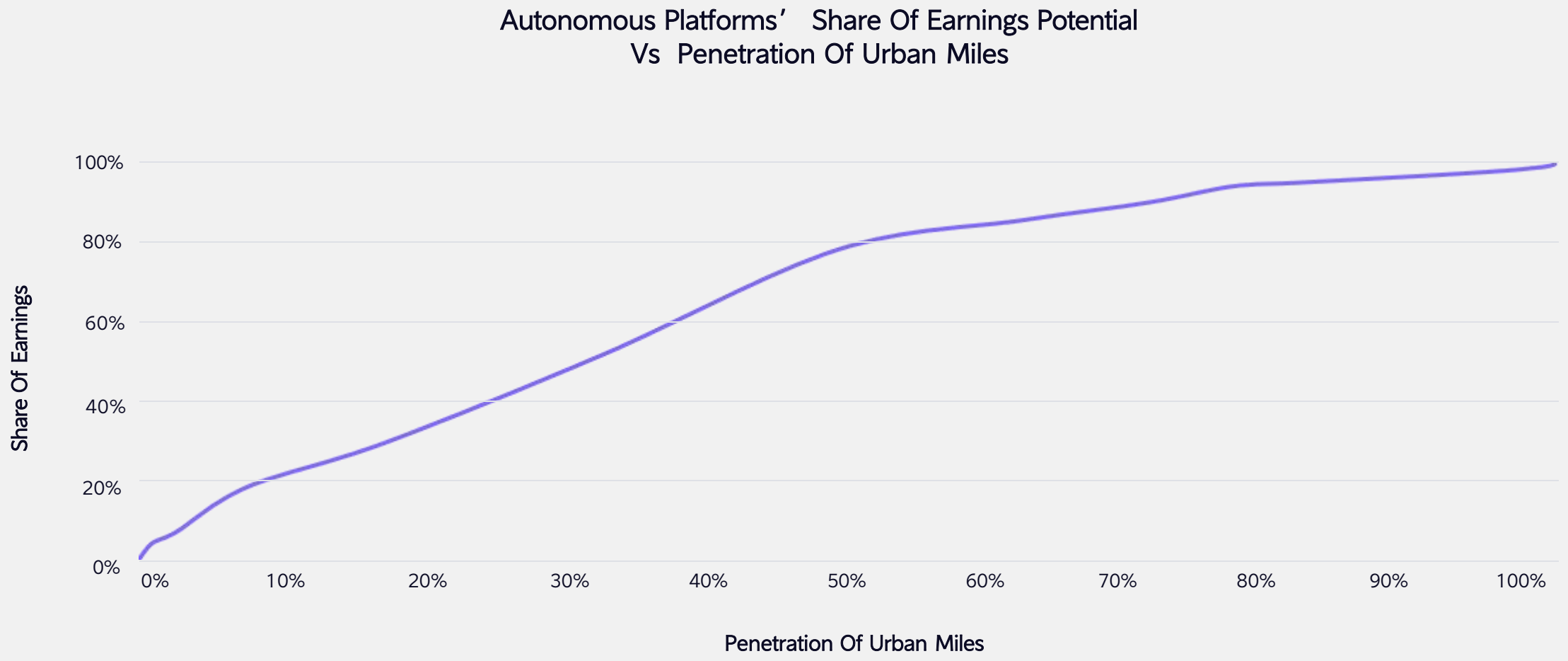
以每英里0.25美分的价格，自动驾驶交通可以为更广泛的人群提供服务，而不是今天人类驾驶的乘车服务。与此同时，根据消费者对时间的重视，更高价位的需求可能会很大。



*$11 Trillion is the addressable market, not the revenue we expect in 2030, as we do not expect autonomy to penetrate all addressable miles. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Big Ideas 2024—智能小巨人科技编译版

促进城市前50%自主里程的平台会产生大部分收益



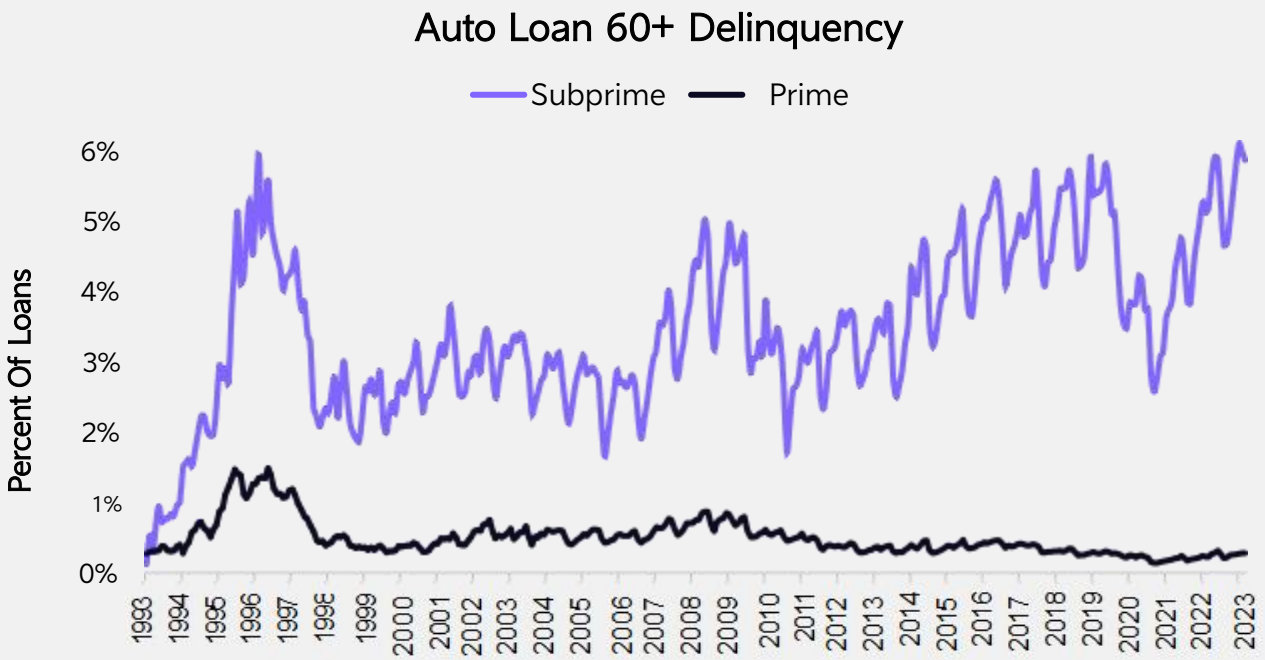
Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

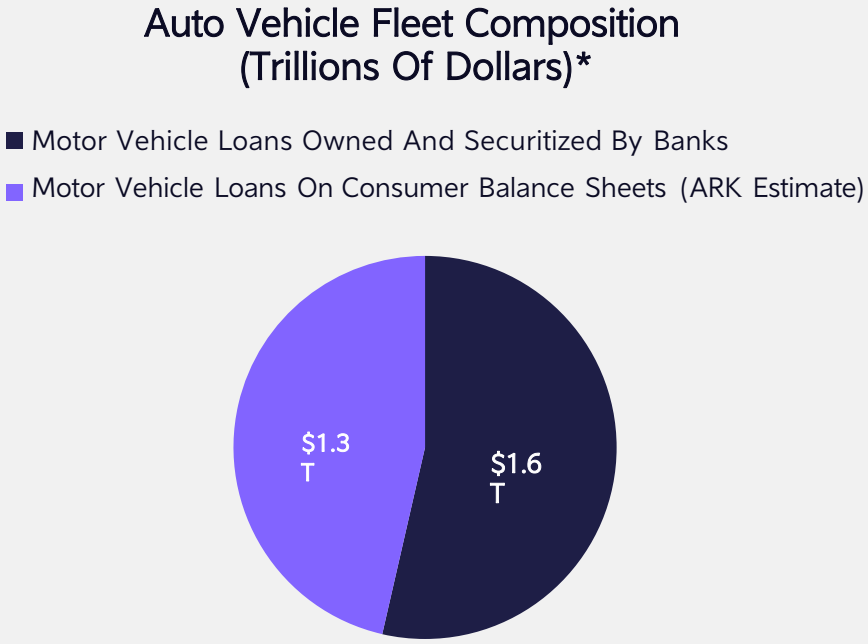
Big Ideas 2024—智能小巨人科技编译版

自动电动汽车的采用可能会破坏美国汽车贷款行业

在过去三年中，加息使新车每月的汽车贷款还款额增加了约27%，从581美元增加到739美元。因此，最近拖欠60天以上的次级汽车贷款数量创下历史新高。

多亏了赖特定律，电动汽车的价格会继续下降，将更多的里程转移到电动平台上，并降低汽油动力汽车的价值。因此，目前金融机构资产负债表上的约1.6万亿美元汽车贷款——主要用于汽油动力汽车，可能在未来10年内面临风险。



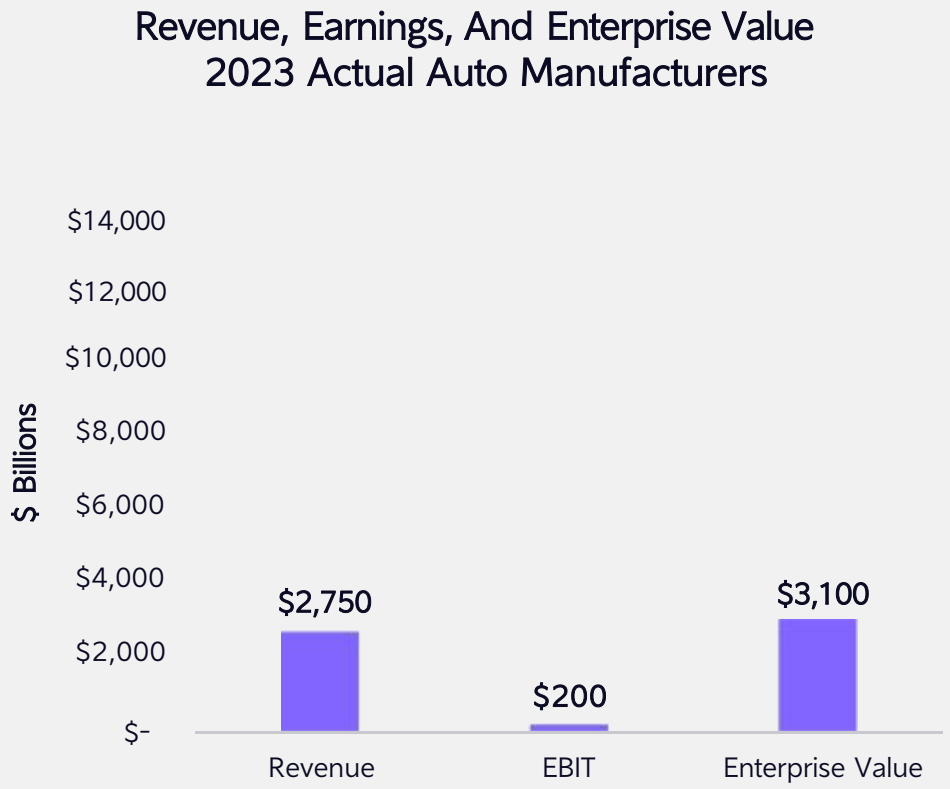


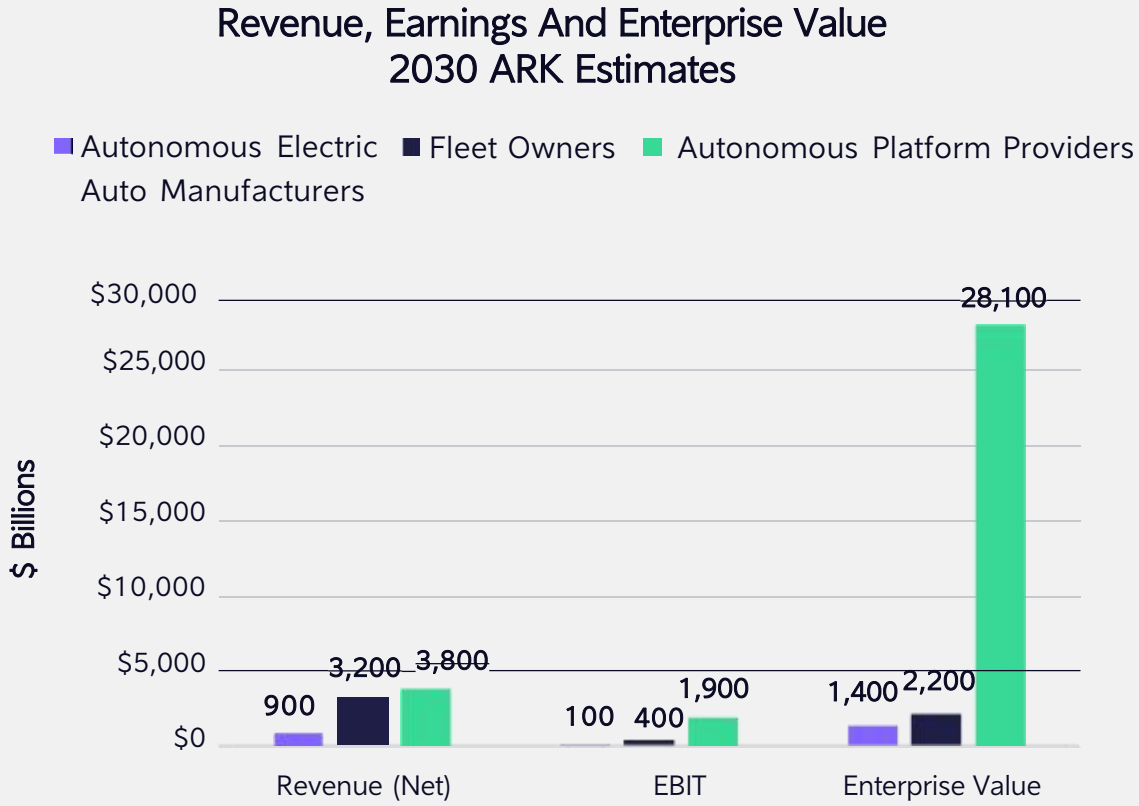
Note: Wright's Law states that for every cumulative doubling of units produced, costs will fall by a constant percentage. *Motor Vehicle Loans Owned and Securitized data as of Q3 2023. ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, as of January 3, 2024, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Big Ideas 2024—智能小巨人科技编译版

自动驾驶网约车平台可以在2030年创造约28万亿美元的企业价值

以15倍的EBIT测算，到2030年，自动驾驶网约车平台的企业价值将达到28万亿美元，相当于2023年所有汽车制造商的9倍。





Numbers are rounded. EBIT = Earnings Before Interest and Taxes. Autonomous Platform Operators = Autonomous Ride-hail Companies, such as Waymo or Tesla. The chart on the left includes all publicly listed automakers with available CAPIQ data on Enterprise Value, Revenue, and Operating Income. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Big Ideas 2024—智能小巨人科技编译版

Research By:
Tasha Keeney, CFA
Director of Investment Analysis & Institutional Strategies
Daniel Maguire, ACA
Research Associate

自主物流

降低成本和重塑供应链

本报告为ARK投资出品的年度研究报告，智能小巨人科技进行了编译，仅供学习参考，请勿用于商业用途

Sources: ARK Investment Management LLC, 2024 Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

自主物流将在未来五到十年内将货物运输成本降低15倍。自主无人机和机器人届时将完成数百万次交付，而自主卡车运输公司记录了数千万英里，并且无需安全驾驶员。

人工智能被证明优于人类飞行员和司机，鼓励监管机构允许真正的自主操作，这将改变购物行为。

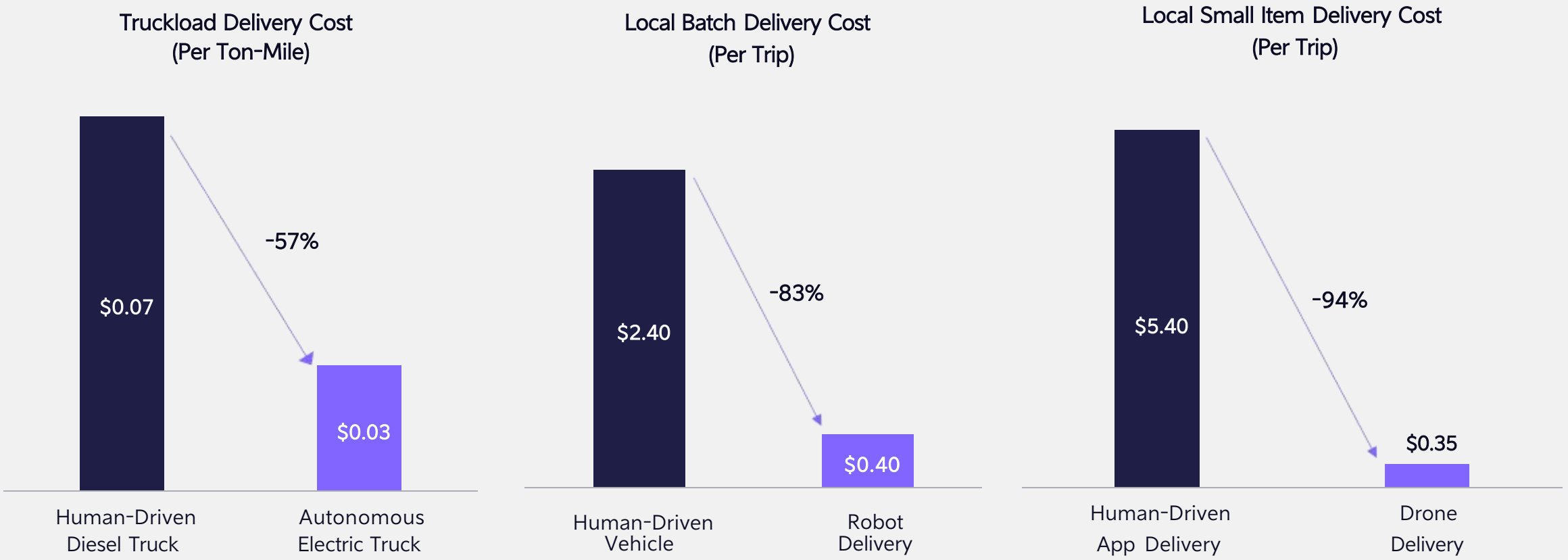
自动驾驶汽车将深刻影响医疗保健，因为能加速救生用品的运输，特别是在新兴市场。

根据ARK的研究，自主配送收入可能从今天的0增长到2030年的9000亿美元。

Sources: ARK Investment Management LLC, 2024 Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

地面的和飞行的自动驾驶车辆可以大幅降低供应链成本

根据我们的研究，自动驾驶汽车应该以比人在循环系统更高的利用率运行，从而创建更具成本效益的最后一英里交付系统。



Note: Drone price per mile has been updated with our latest assumptions for replacement costs, launching and charging infrastructure, insurance, and labor costs. Fees for drone and robot delivery are shown net of infrastructure costs (outside of charging and launch/land), which we believe could either be born by the drone or robot delivery operators or shared with logistics or retail partners. ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources as of December 7, 2023, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

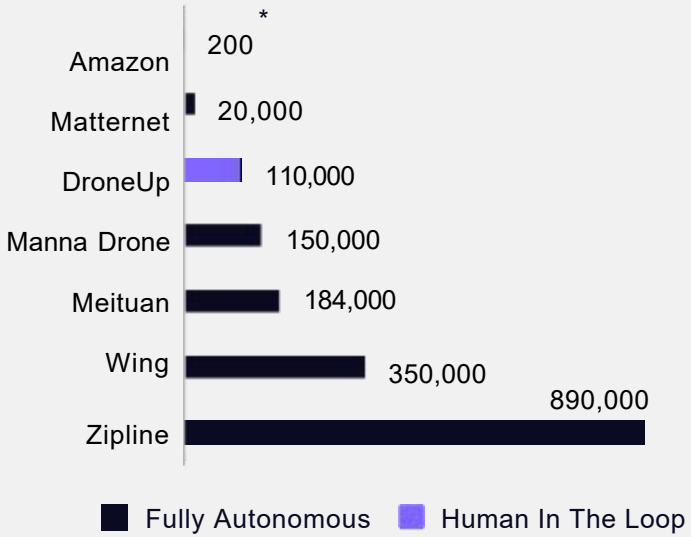
Big Ideas 2024—智能小巨人科技编译版

专有数据可能决定自主物流的商业成功

拥有更多真实世界数据的公司应该具有竞争优势。垂直化和制造合作伙伴关系对成功也至关重要。

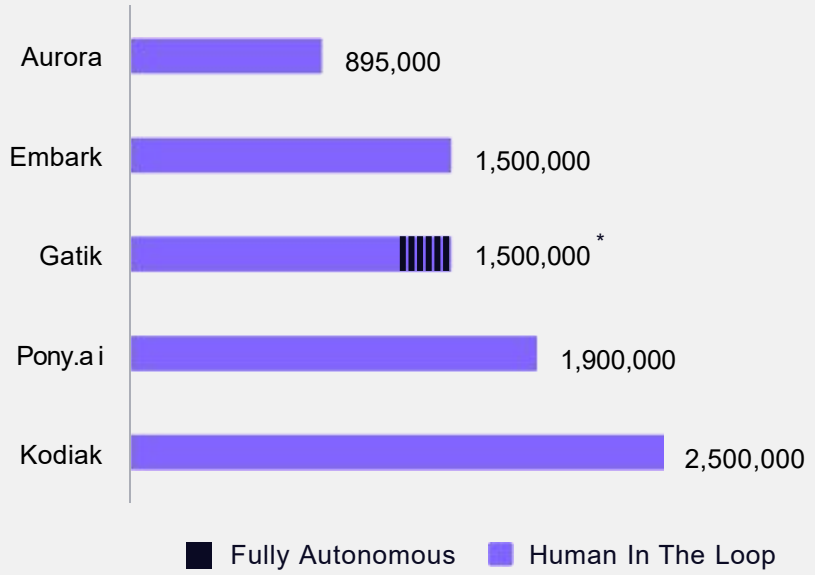
Drones

Cumulative Number Of Commercial Flights



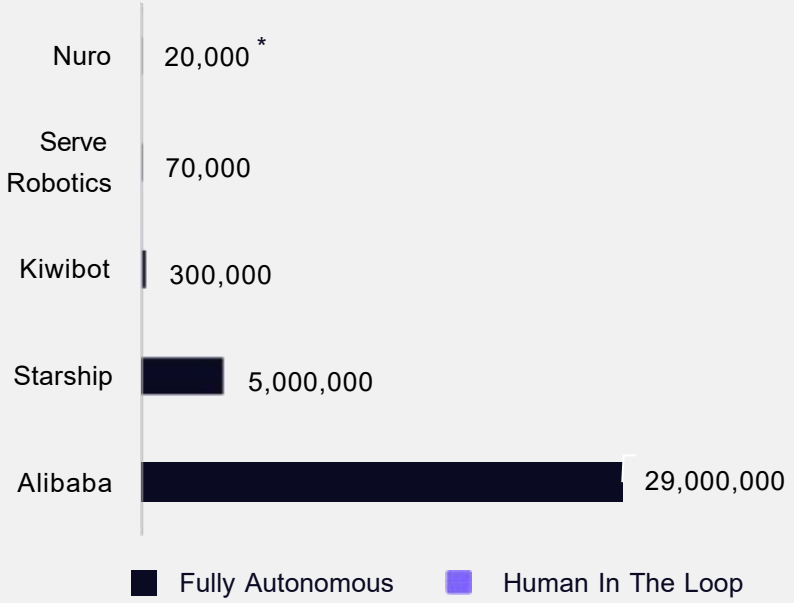
Autonomous Trucks

Cumulative Miles Traveled



Rolling Robots

Cumulative Number of Deliveries

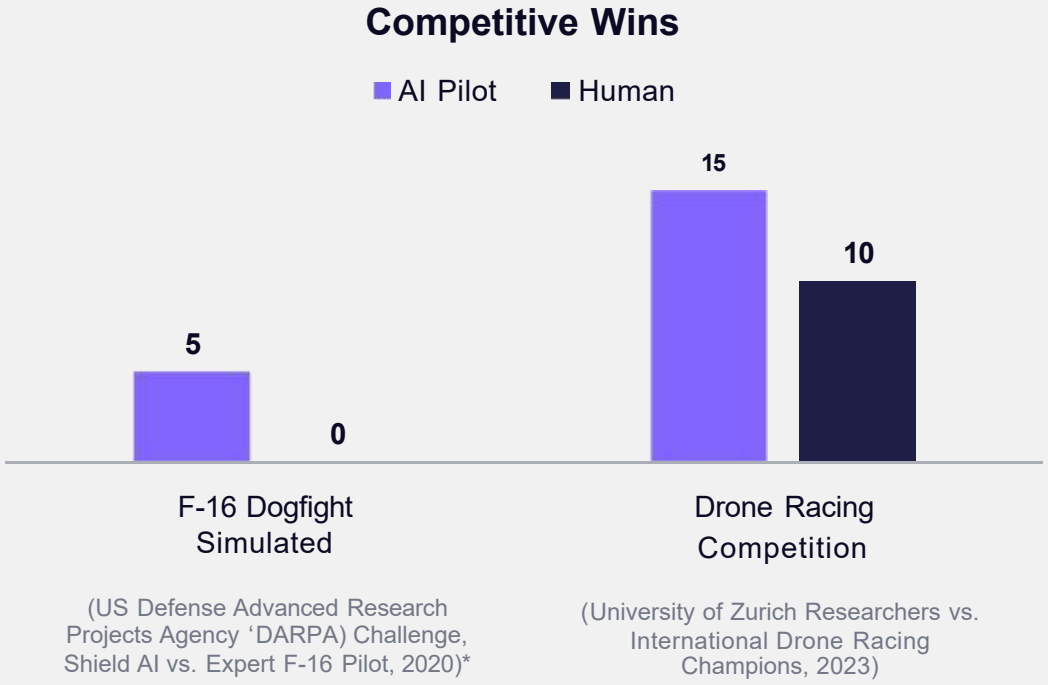


Note: All truck miles traveled are latest available real-world reported miles; Gatik Class 6 trucks have operated commercially without a safety driver in some instances and the dashed navy lines are a representation of this. *Figures estimated based on available data. Robot delivery companies have different package capacities per robot, so some can make more deliveries per run than others. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources as of January 11, 2024, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

人工智能飞行员的表现似乎优于人类飞行员

和人类飞行员相比，人工智能飞行员拥有巨大的数据优势。Zipline无人机记录的商业飞行里程可能比人类的要多。在与人类专家战斗机飞行员进行的头对头模拟F-16格斗中，Shield AI以5-0获胜。*

在无人机比赛中，经过深度强化学习训练的人工智能在25次中超过专业人类飞行员15次，单圈速度提高了10%左右。

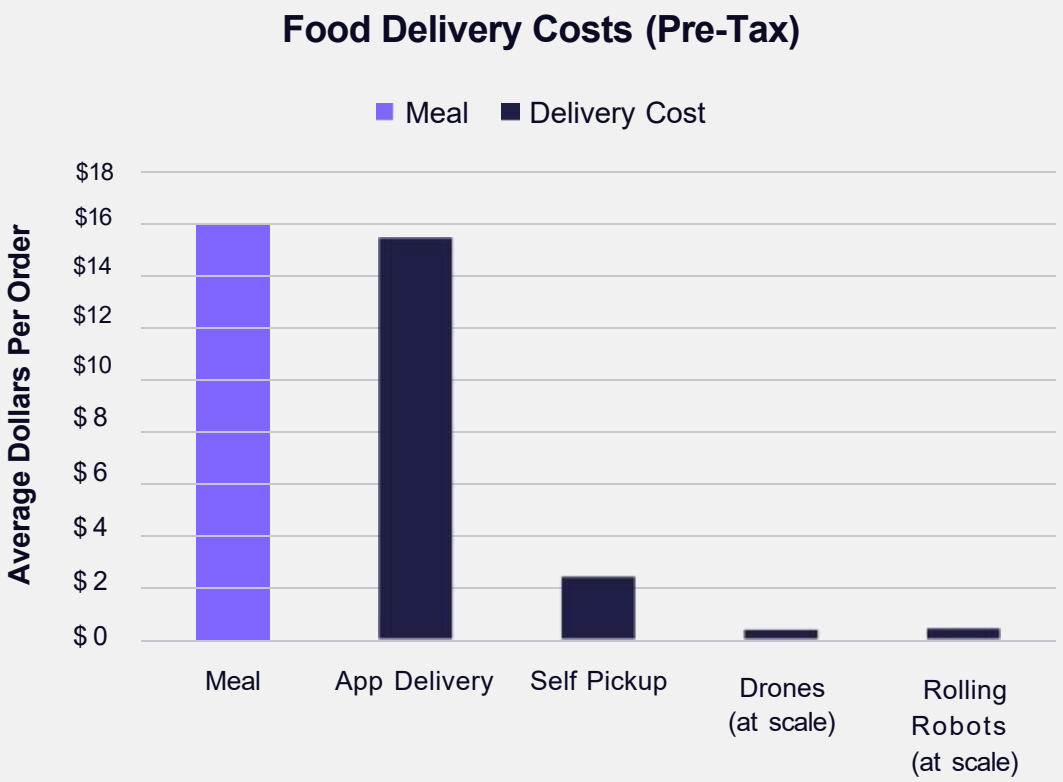


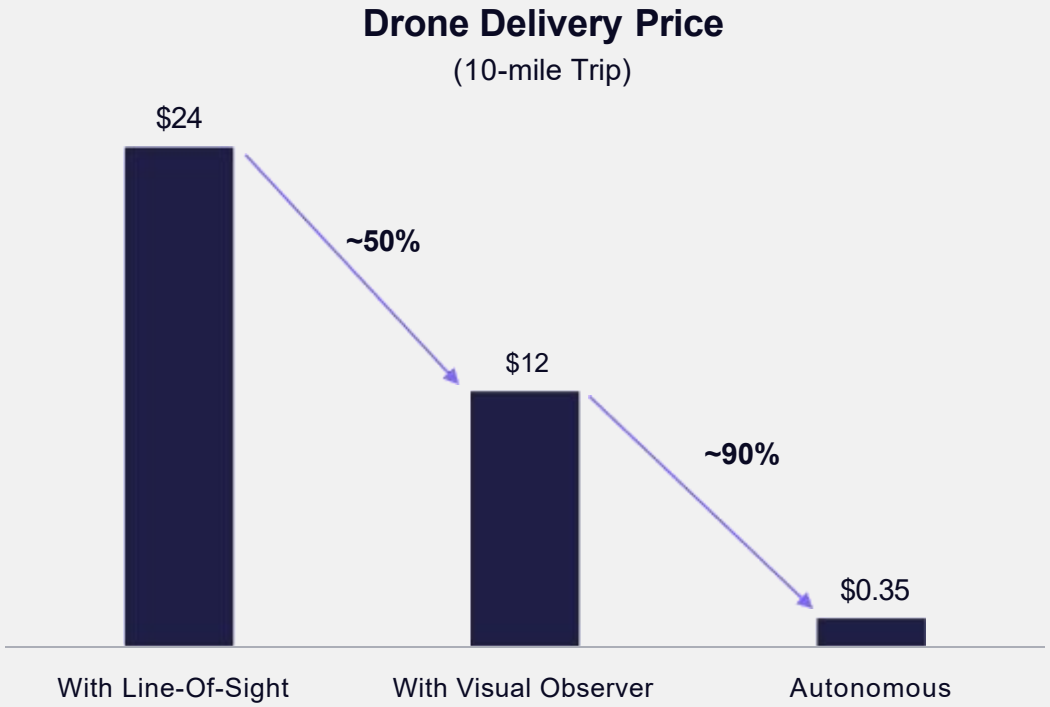
*Note: Heron Systems, now part of Shield AI, won the dogfight. ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources as of December 7, 2023, which may be provided upon request. Numbers are rounded. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

得益于监管部门的批准，自主无人机会降低食品配送成本

在COVID期间和之后，送餐费使基准菜单订单的平均成本提高了两倍。

由于最近获得了FAA的批准，没有视觉观察者的“超越视线无人机”能大幅降低送餐成本。

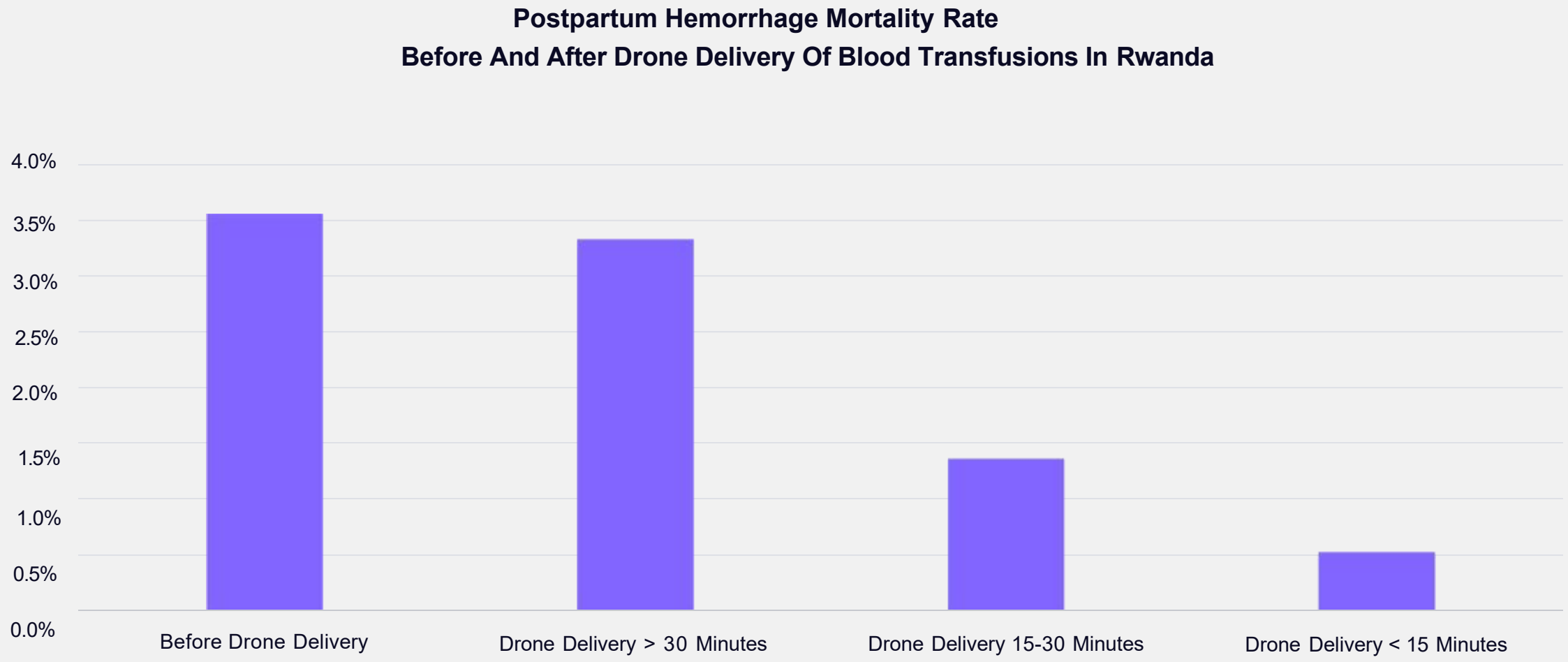




Note: Numbers are rounded. ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources as of December 7, 2023, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

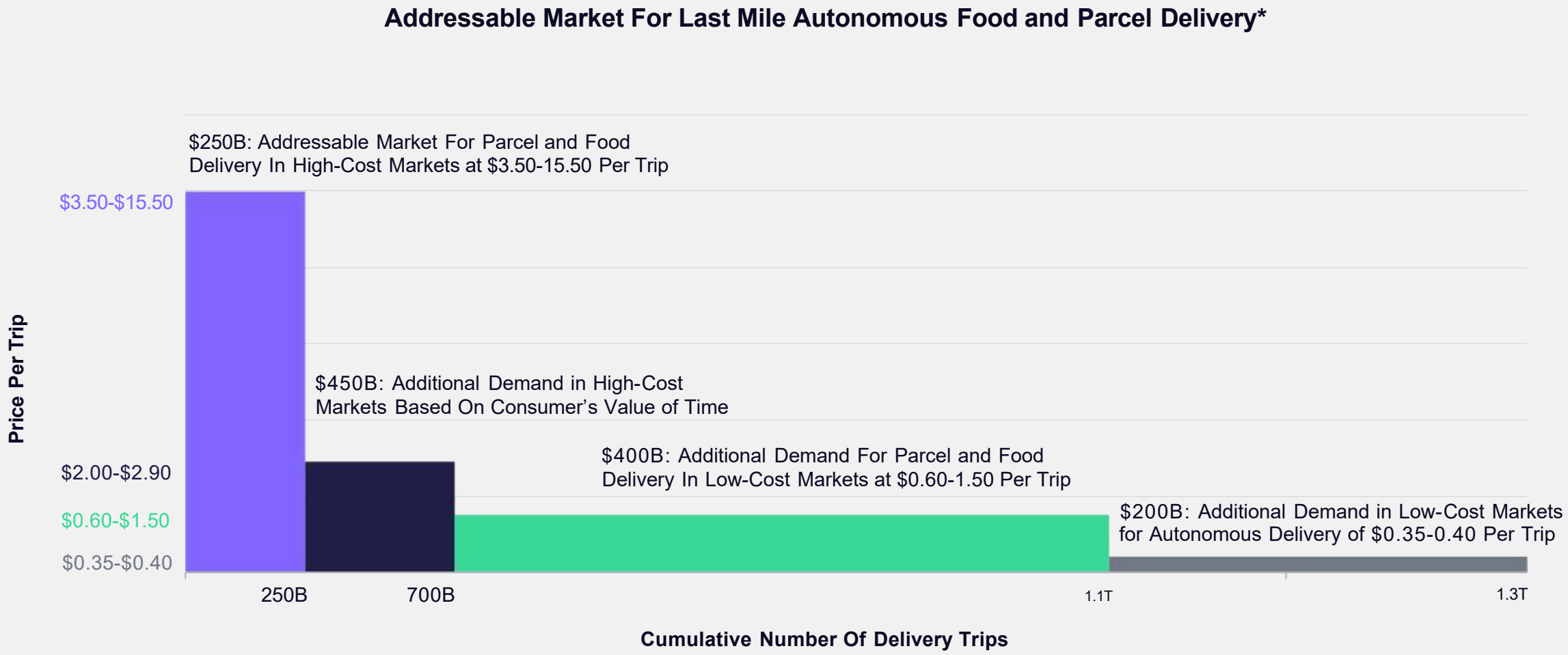
无人机正在拯救生命

在没有道路基础设施的地区，Zipline无人机可以在不到15分钟的时间内输送血液，将与产后出血相关的死亡率改善了80%。



Sources: ARK Investment Management LLC, 2024, based on data from Jeon et al. 2022. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

食品和包裹的自主配送可以创造一个1-2万亿美元的潜在市场

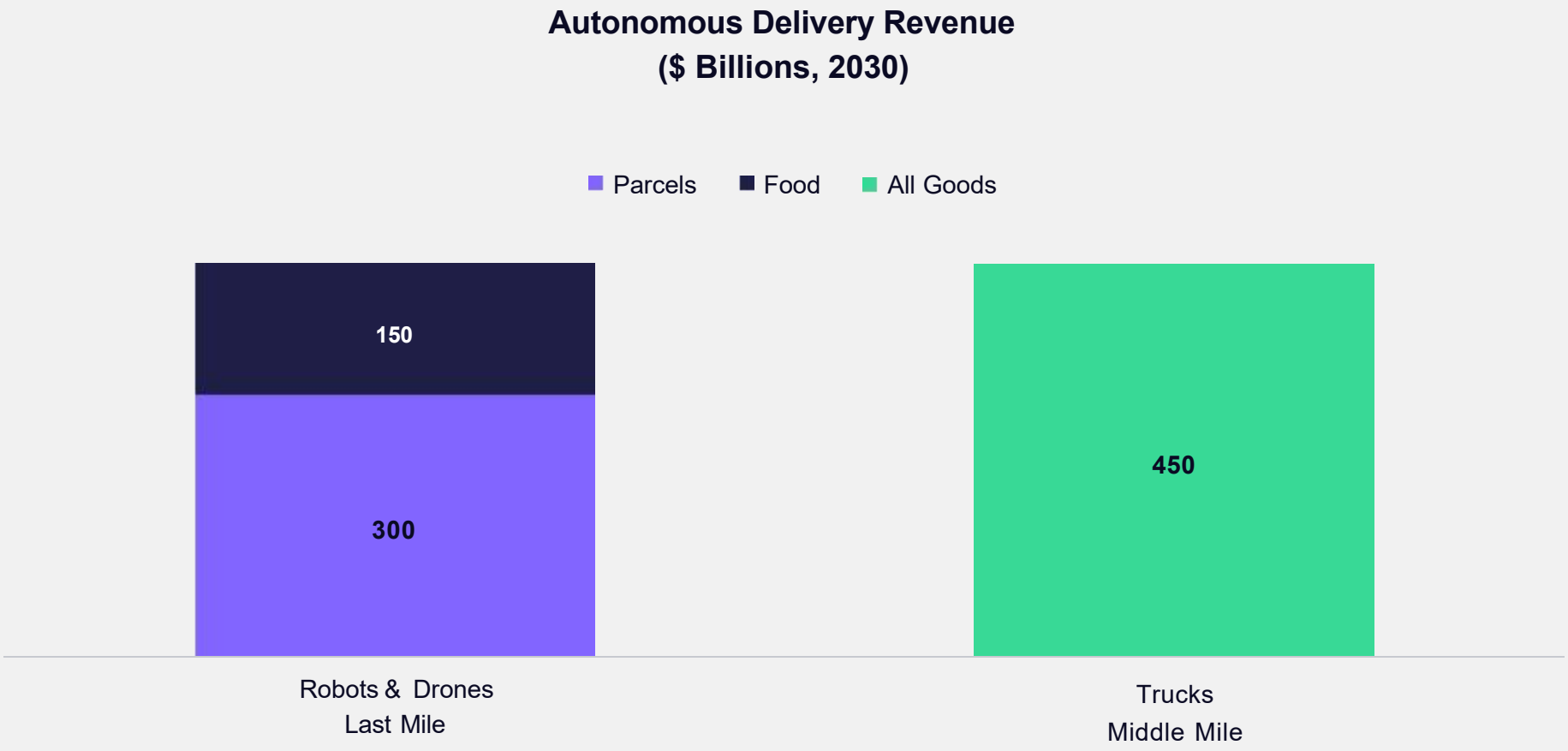


*Numbers in the graph are rounded. $1-2 Trillion is the addressable opportunity, but total revenues / market size by 2030 will depend on penetration rates, which are detailed in slides below. ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources as of December 7, 2023, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Big Ideas 2024—智能小巨人科技编译版

到2030年，全球自主配送收入可能达到9000亿美元

机器人和无人机配送食品和包裹的费用在2030年可能达到4500亿美元，因为负担得起的技术支持的递送重塑了消费者的习惯。与此同时，到2030年，自动卡车运输收入可能达到4500亿美元，因为自动卡车与无人机和机器人技术相结合，改变了企业高效、快速地运输货物的方式。

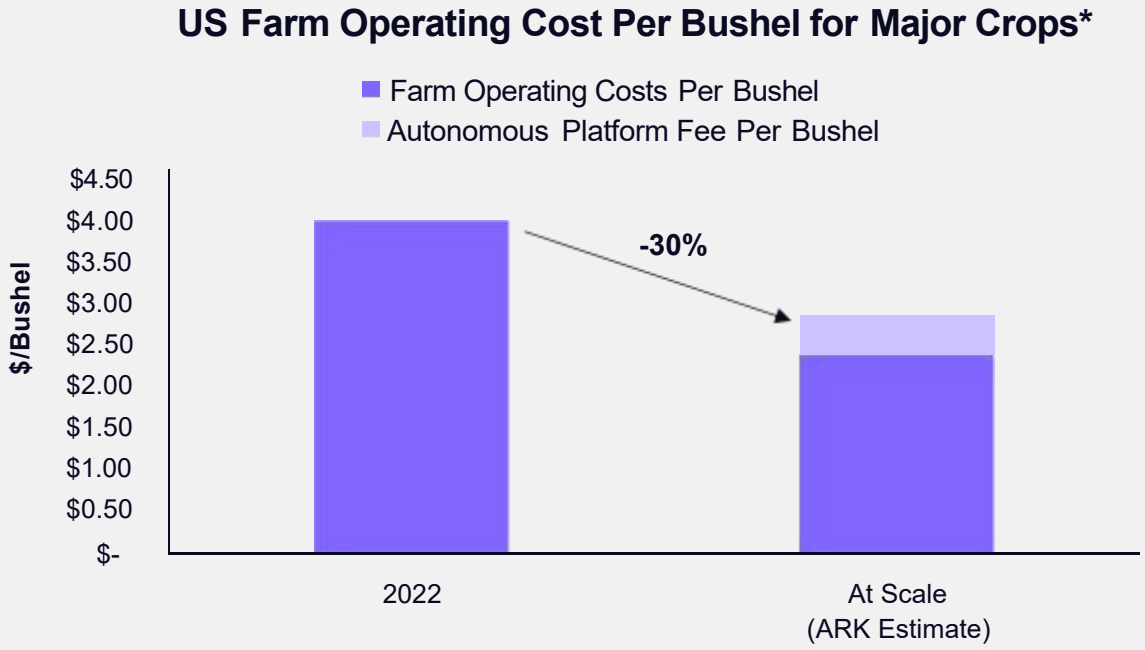


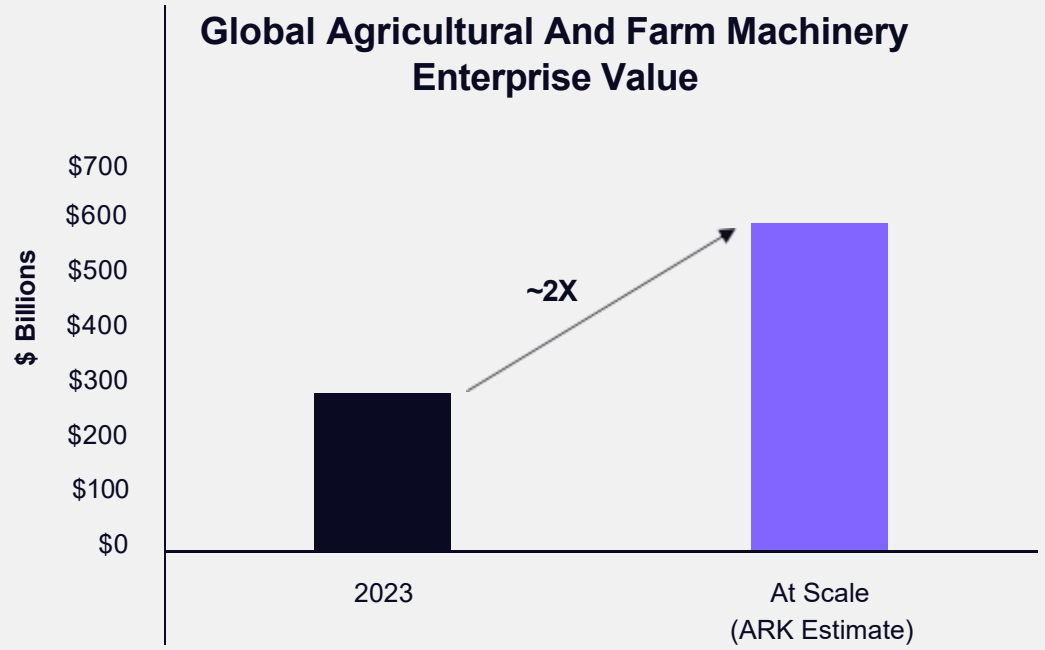
Note: ARK updates its research models often and most recently adjusted the adoption curve for autonomous technology, which resulted in a lower market forecast than previously estimated. ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources as of December 7, 2023, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

自主物流可以使精准农业的企业价值翻倍

由于育种、转基因和农业生物制剂带来的持续自动化和产量提高，每蒲式耳生产的运营成本——包括成本和产量的指标——在美国主要作物中可能下降约30%。*

以种植为商业模式的农业公司可以通过该技术节省的成本来产生自主物流平台费用，从而实现类似软件的利润。因此，他们的集体企业价值可能大约翻一番，达到约6000亿美元。**





*This analysis focuses on "Major Crops"—Corn, Soybean, and Wheat—which ARK defines as the top three crops in the US based on bushel production. Numbers are rounded. **When accounting for different cost compositions and adoption rates globally. This assumes a 50% autonomous platform fee and a 19X EV/EBITDA multiple on autonomous service earnings. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, using the latest available data as of January 4, 2024, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Big Ideas 2024—智能小巨人科技编译版

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可复用火箭

开启外太空商业

Sources: ARK Investment Management LLC, 2024. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

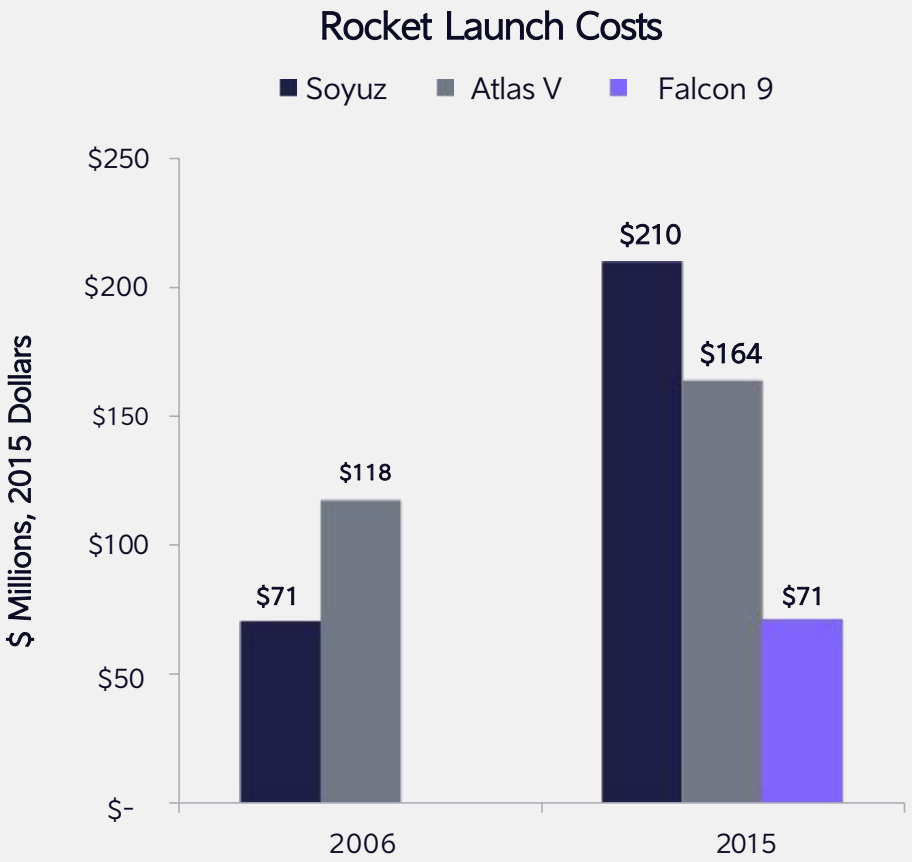
可重复使用的火箭大大降低了发射成本，为商业开放了外层空间，并创造了直接与设备相连的卫星连接等新服务。根据ARK的研究，到2030年，卫星连接收入可能达到1300亿美元，仍然只是大约2万亿美元电信收入的一小部分。

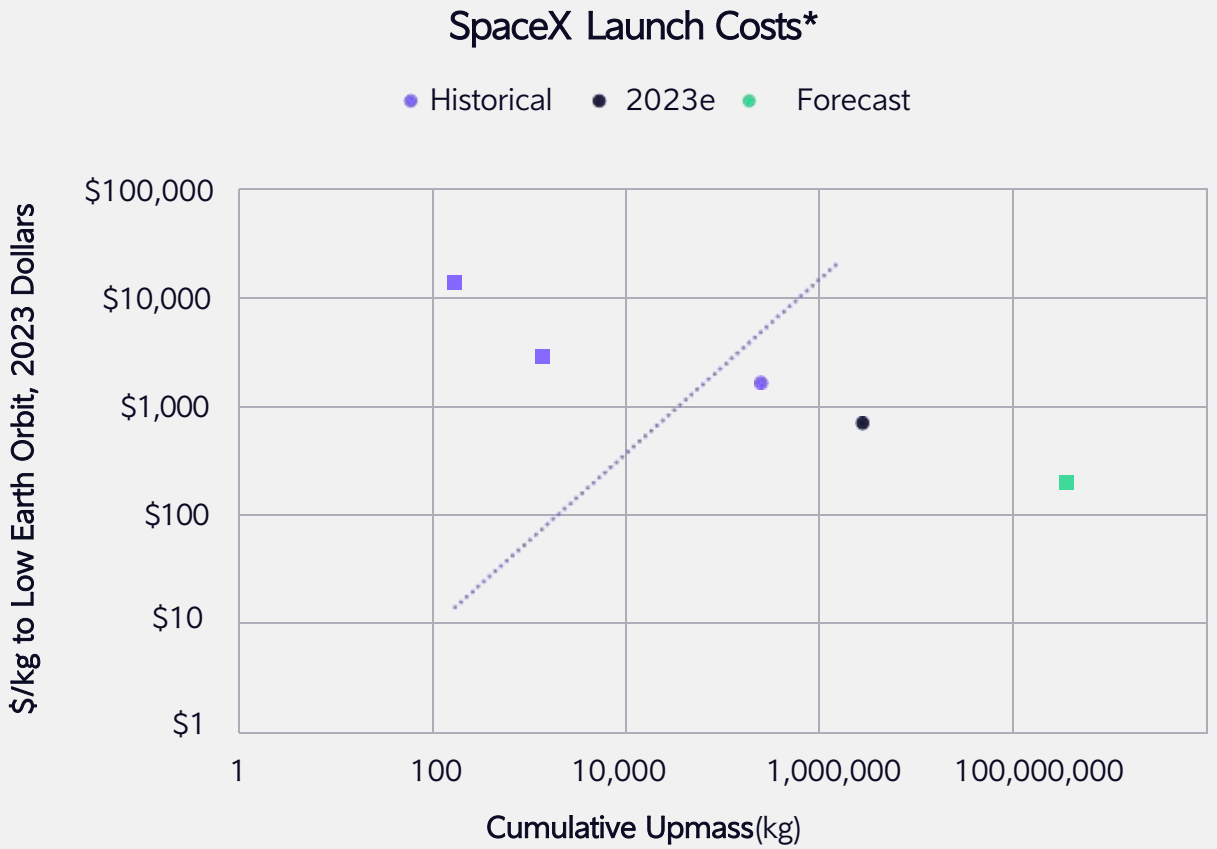
高超音速点对点飞行可能在2030年产生约350亿美元的收入，从长远来看，有可能达到3500亿美元的潜力规模。

Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including CompaniesMarketcap.com 2024, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

可重复使用的火箭会将发射成本降低一个数量级…… 或者两个!

SpaceX的可重复使用的火箭Falcon 9结束了飙升的发射成本。通过19次重用Falcon 9助推器，SpaceX在2023年将其年度发射节奏提高了近60%，达到96。



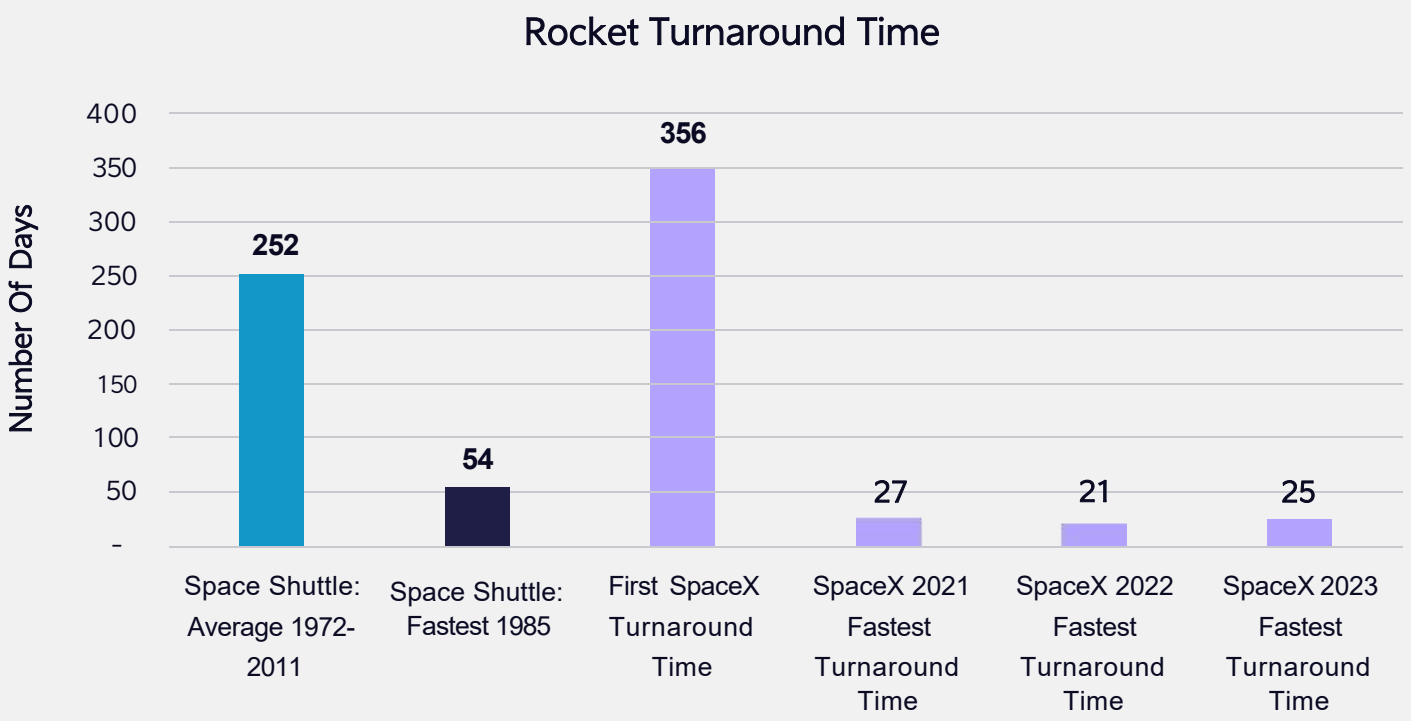


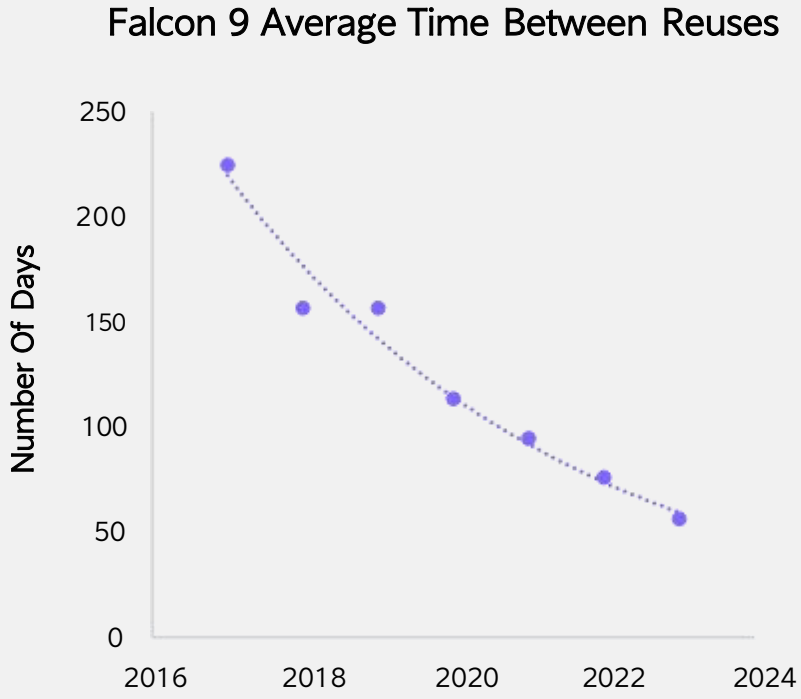
*Forecast timeline dependent on the speed of development of SpaceX's Starship. Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

SpaceX正在创纪录的时间内翻新火箭

当航天飞机每次发射的成本约为15亿美元时，行业专家认为可重复使用的火箭在经济上是不可能的。SpaceX随后翻转了剧本。

根据ARK的研究，Falcon 9的第一阶段的翻新费用 <100万美元。现在，火箭的周转时间应该与翻新火箭助推器所需的成本成正比，这是跟踪发射成本下降的关键指标。

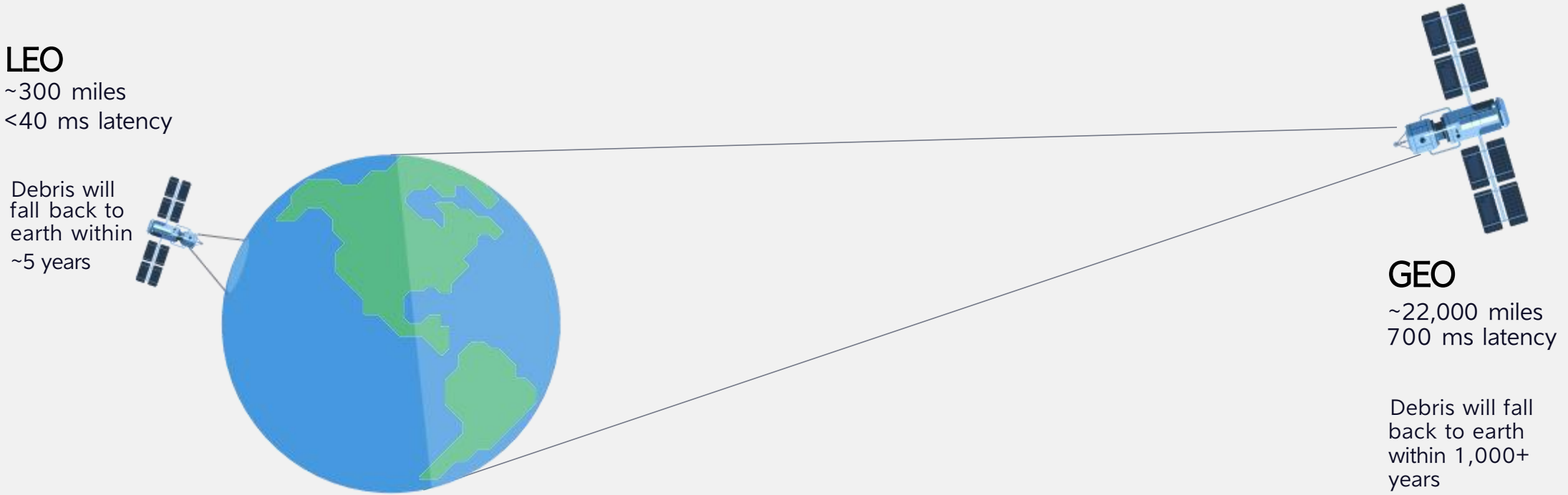




Sources: ARK Investment Management LLC, 2024, based on data from NASA 2023 and SpaceX 2023a, 2023b as of December 11, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

较低的卫星发射成本将能够实现低延迟的连续全球覆盖

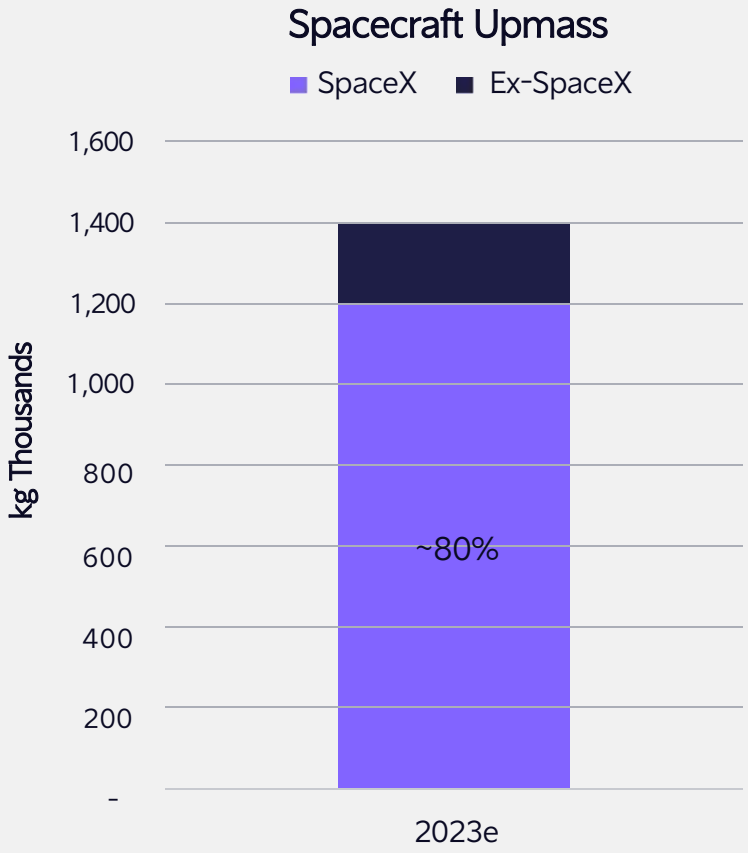
虽然延迟阻止了地球静止轨道 (GEO) 卫星提供引人注目的宽带互联网解决方案，但现在成千上万的低成本低地球轨道 (LEO) 卫星可以提供低延迟的服务、持续的全球覆盖，以及直接连接到移动设备。

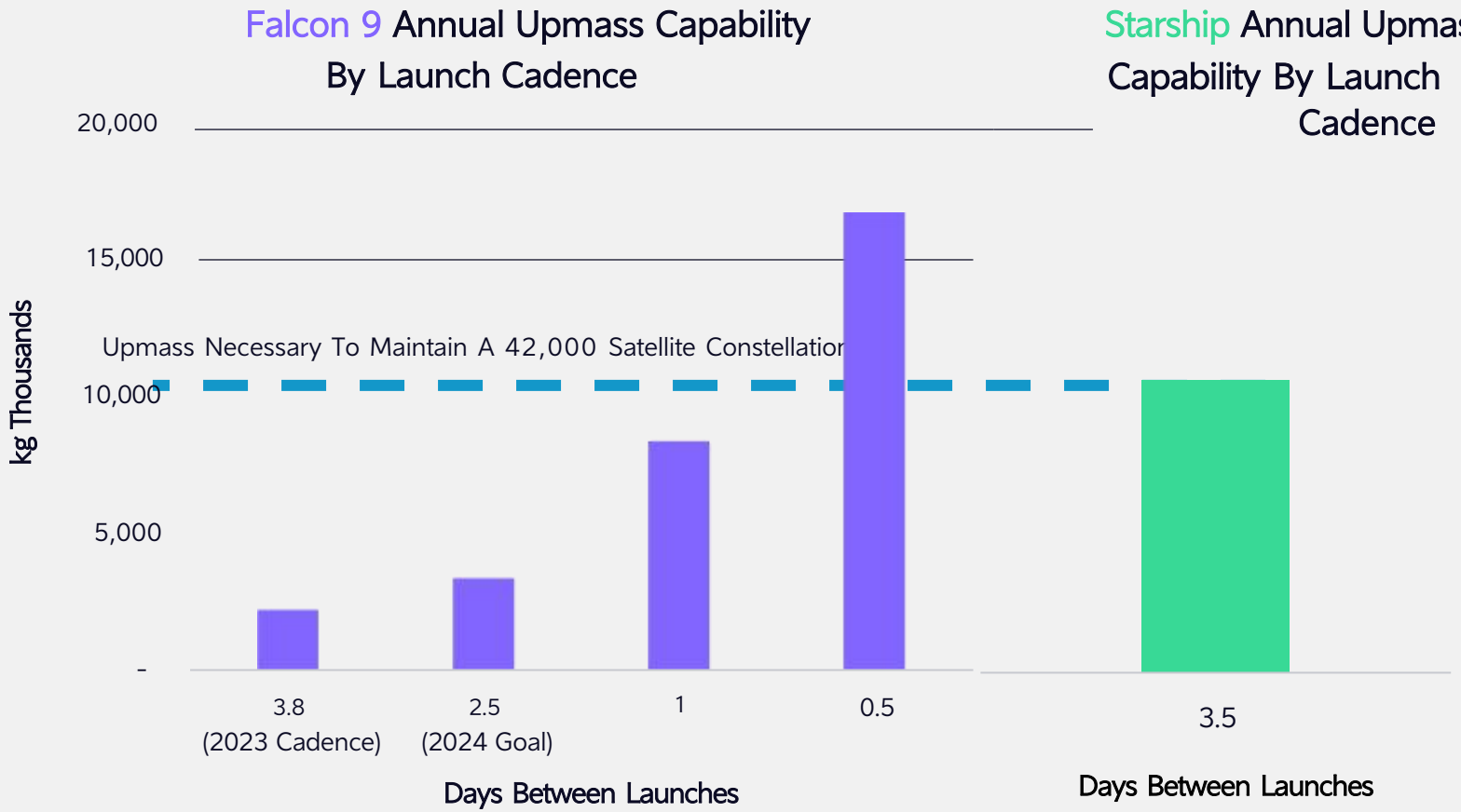


Sources: ARK Investment Management LLC, 2024. based on data from Starlink 2023, SES/ViaSattelite 2023, NEONE 2023 . Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

星际飞船将帮助星链星座发挥其潜力

星际飞船对LEO的有效载荷能力是猎鹰9号(Falcon 9)的5倍。虽然令人印象深刻，但考虑到其卫星的五年寿命，星际飞船仍然必须每3.5天飞行一次，以维持其42,000颗星链卫星的目标星座。截至2024年1月，SpaceX拥有约5,400颗卫星。

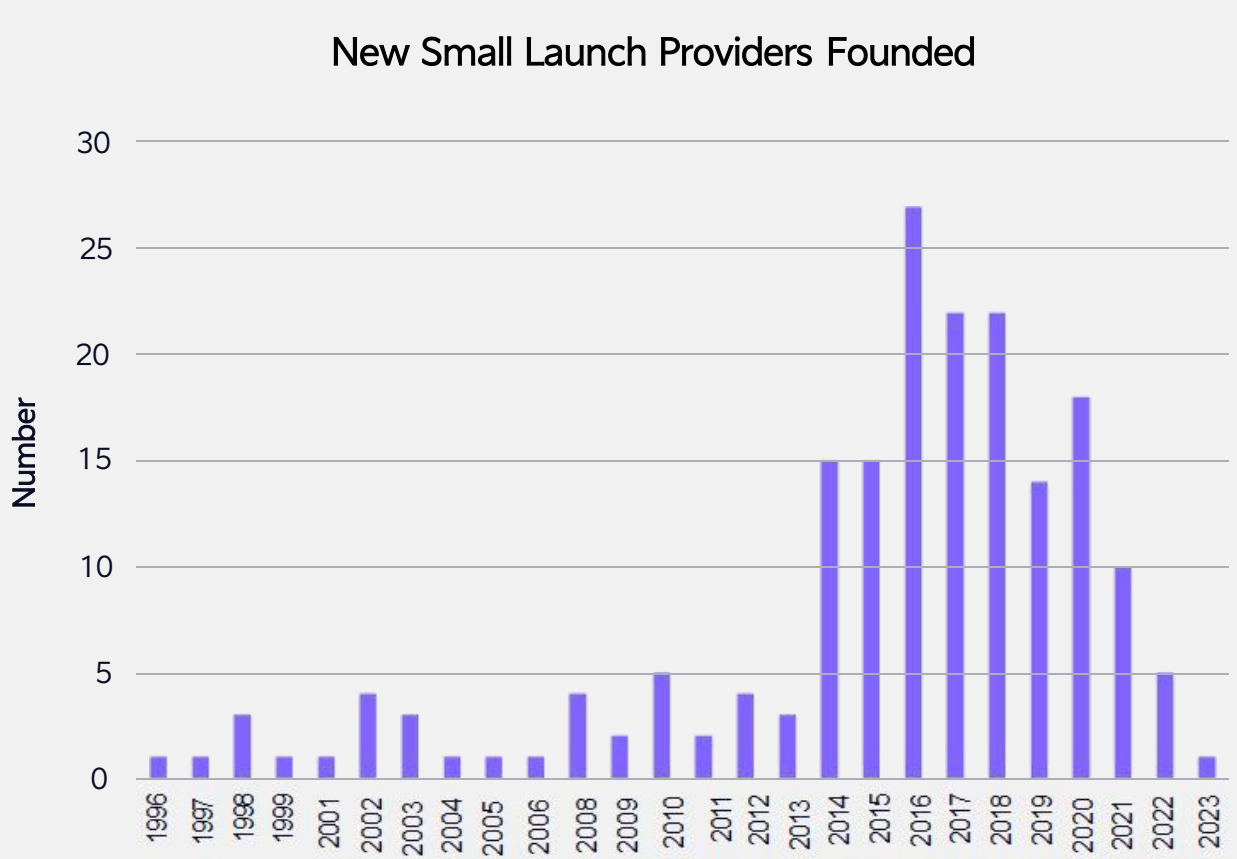


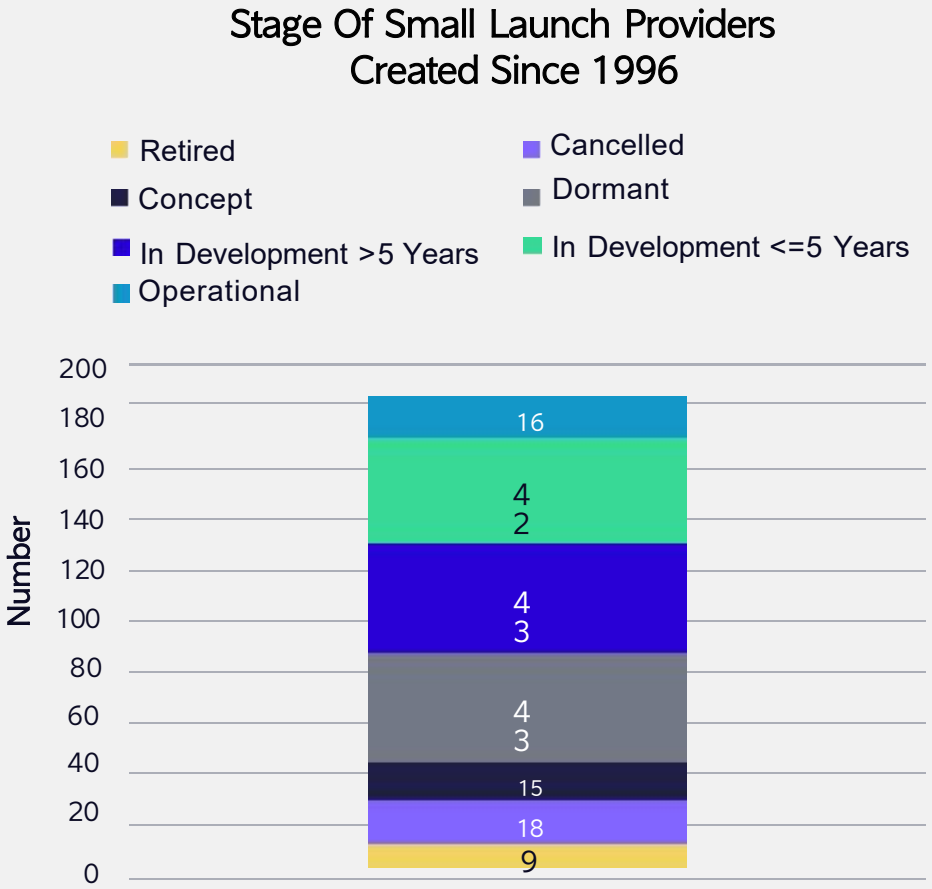


Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including Brycetech 2023a, 2023b, 2023c, and McDowell 2024 as of January 23, 2024, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

小型发射提供商激增，但可能不是太空的赢家

在资本支出繁荣之后，行业往往会整合。在航天工业中，虽然发射能力至关重要，但更大的机会可能在于低发射成本所带来的服务。如今，自1996年以来创建的186家小型发射提供商中，只有16家在运营。

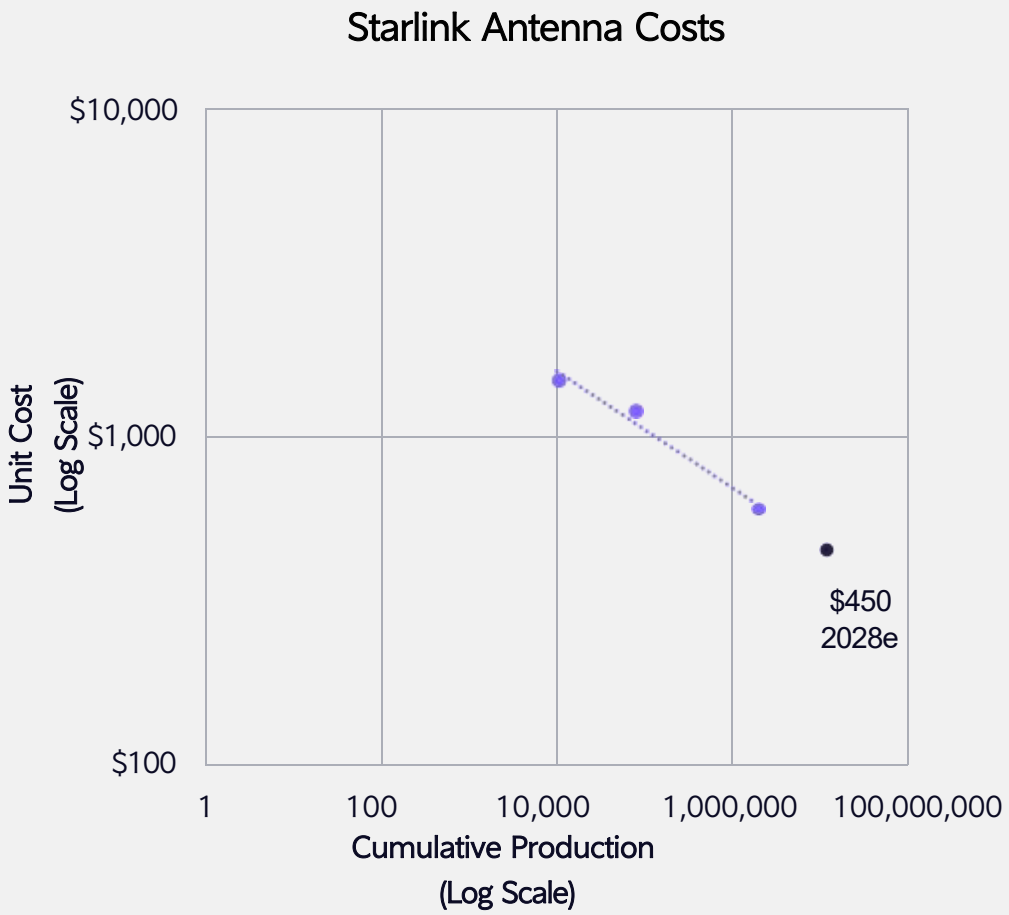


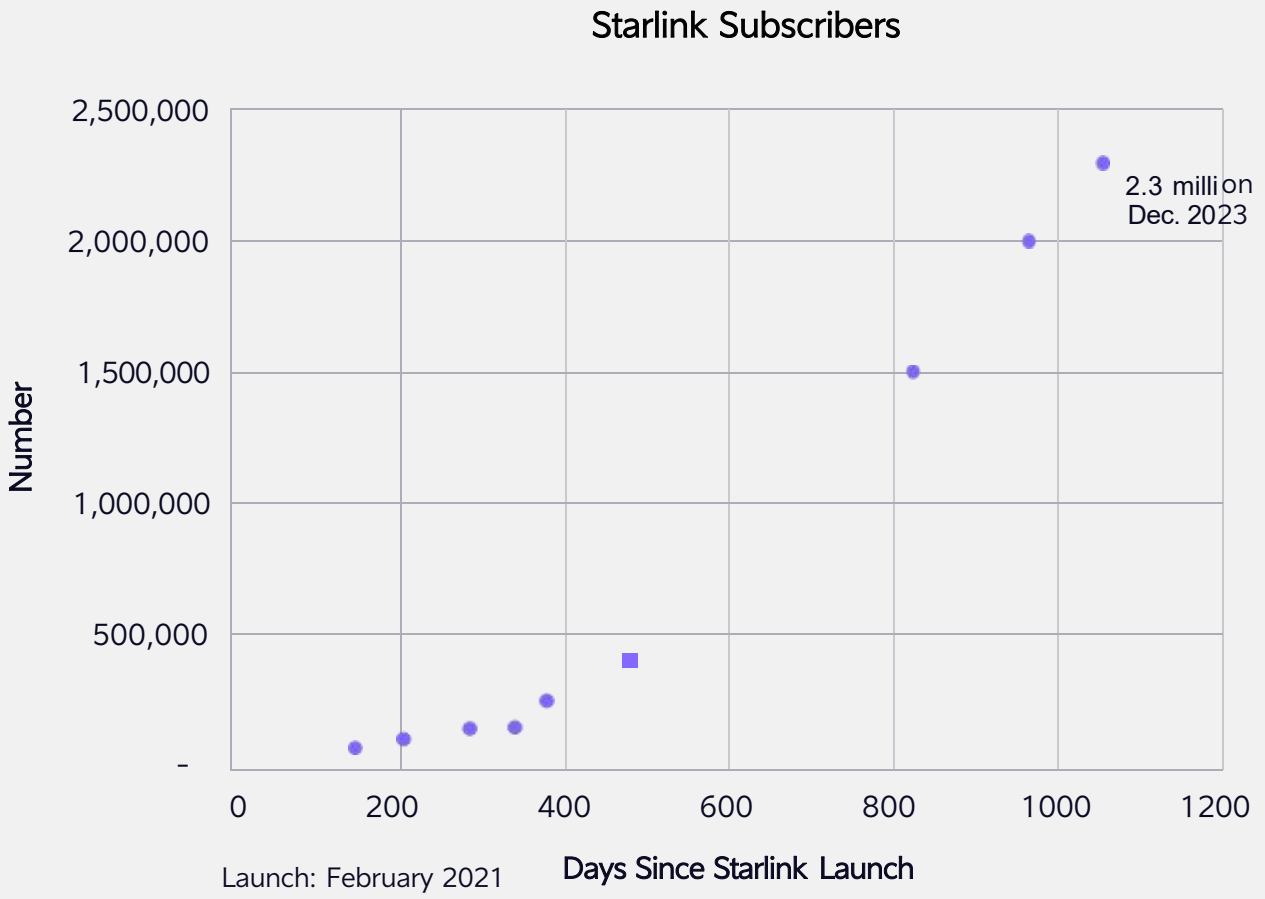


Sources: ARK Investment Management LLC, 2024, based on data from NewSpace Index 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

天线成本继续下降

SpaceX目前生产的用户终端价格低于向客户收取的599美元。较低的天线成本应该使SpaceX能够有利可图地扩展Starlink。





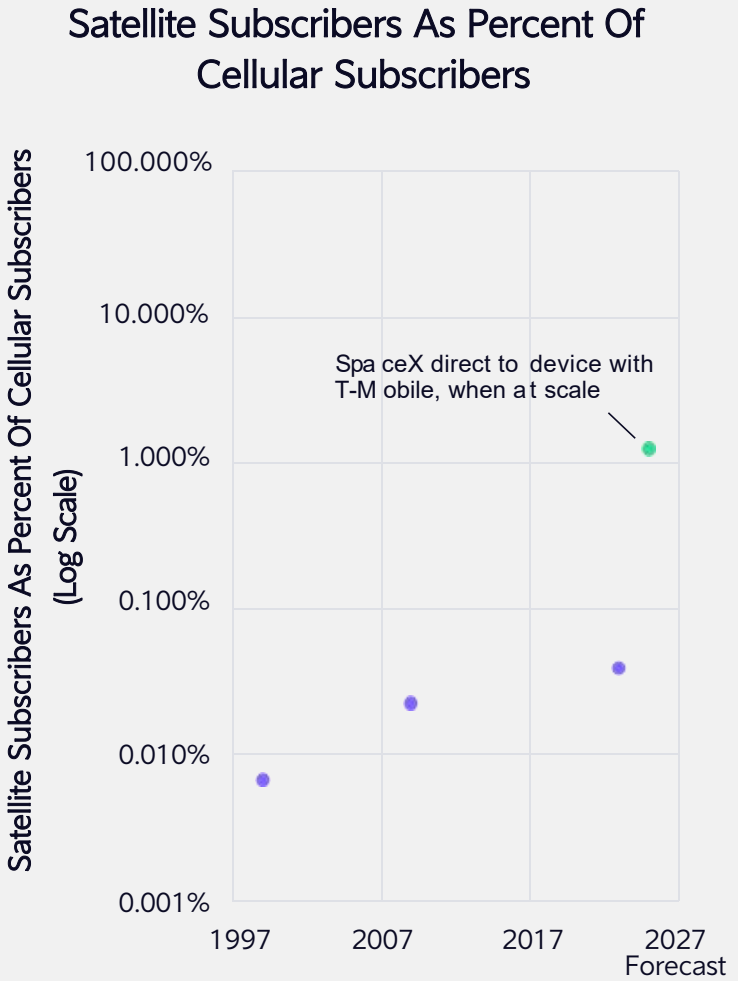
Sources: ARK Investment Management LLC, 2024, based on data from SpaceX as of September 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

卫星连接收入每年可能超过1300亿美元

ARK相信，随着时间的推移，所有电信运营商都将采用直接到设备的功能。

		潜在订户*		年收入*		潜在市场年规模*
直接到设备		8 billion	✖	$6	=	~480亿美元
无法接入宽带的全球家庭用户		600 Million	✖	$60	=	~400亿美元
房车		11 Million	✖	$1,620	=	~180亿美元
休闲船		8.5 million	✖	$1,620	=	~140亿美元
商用飞机机队		25 Thousand	✖	$225,000	=	~60亿美元
游轮，军舰，商船		100 Thousand	✖	$60,000	=	~60亿美元

Total: ~1320亿美元



*Forecasts. Source: ARK Investment Management LLC, 2024. This ARK forecast is based on a range of data sources, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

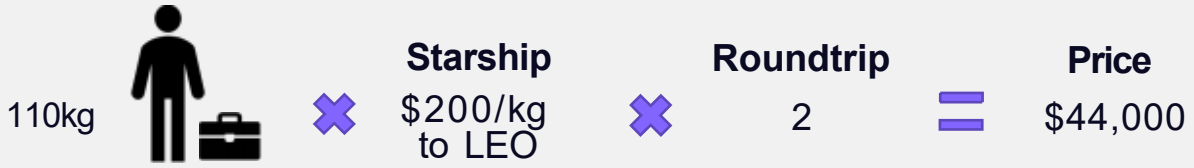
到2030年，高超音速飞行可能是一个约350亿美元的市场，长期有望扩展到约3500亿美元

根据美国交通部的数据，休闲旅行者愿意花费他们估计每小时家庭收入的60%-90% 来节省一小时。*

与往返28小时的常规飞行相比，ARK估计高超音速飞行只需6小时，为每个旅行者节省约22小时。

考虑到典型的成本和潜在的时间节省，ARK的研究表明，头等舱乘客应该愿意花费44,000美元进行高超音速飞行。

如果发射成本下降符合ARK的预期，那么到2030年，高超音速飞行的早期采用者将产生350亿美元的收入。



潜在市场预测及构成

全球航空公司乘客总数: 67亿

↓ 5% 的航班是长途航班

长途航班的乘客数量: 约3.35亿

↓ 5% 的乘客是头等舱

头等舱乘客数量: 约1600万

↓ 50% 的成熟采用率

高超音速飞行的乘客数量: 约800万

↓ $44,000 往返机票费

潜在市场年规模: 约3500亿美元

*Forecast. Sources: ARK Investment Management LLC, 2024. This ARK forecast is based on a range of data sources, including Brycetech and Saic 2021, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

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3D打印

重塑制造

本报告为ARK投资出品的年度研究报告，智能小巨人科技进行了编译，仅供学习参考，请勿用于商业用途

Sources: ARK Investment Management LLC, 2024. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

在汽车制造中，3D打印大大降低了零件数量和产品开发时间表。因此，汽车制造商可以减少库存，节省工具成本。

在医疗保健领域，3D打印正在制造新型手术可定制指南、工具和植入物。

相对于传统制造，3D打印还会带来积极的环境效益。

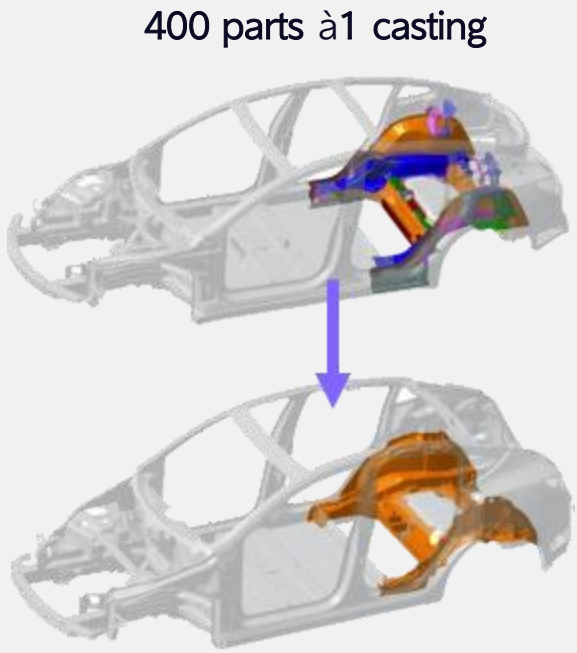
到目前为止，使用3D打印的公司比3D打印设备制造商受益更多。将来，数据反馈循环可能会改变这种动态。

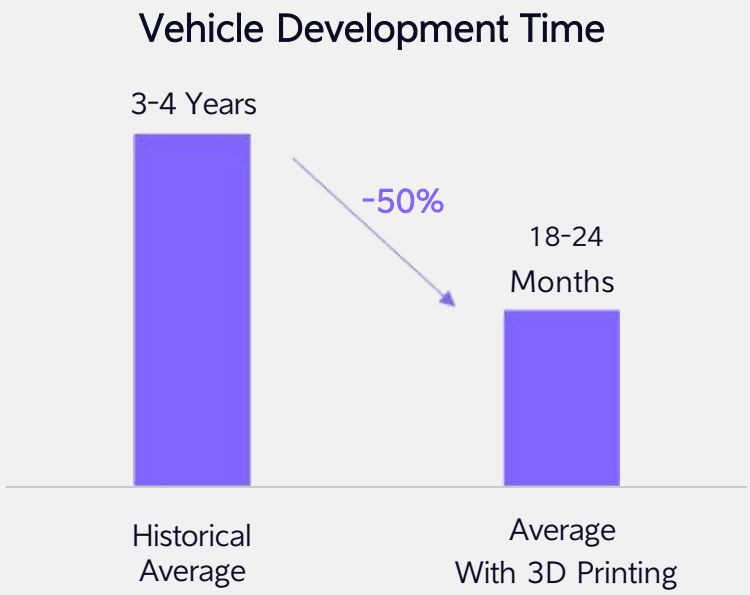
根据ARK的研究，3D打印收入可能在未来七年内以每年40% 的速度增长，从今天的180亿美元增长至2030年的1800亿美元。

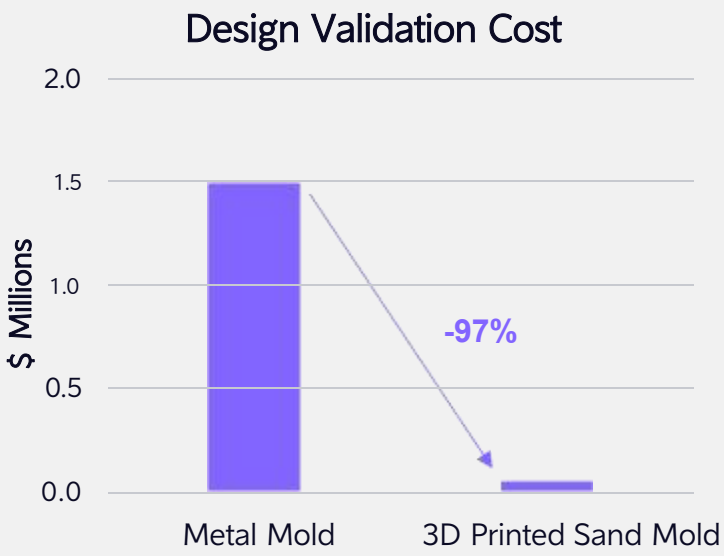
Note numbers are rounded. Sources: ARK Investment Management LLC, 2024. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

归功于3D打印，汽车生产已进入未知领域

据报道，特斯拉正在试验3D打印砂模来铸造汽车车身底部，可以用一个零件代替400个零件，汽车开发时间和模具设计验证成本分别降低50%和97%。3D打印可以在每辆汽车的生产中发挥作用。



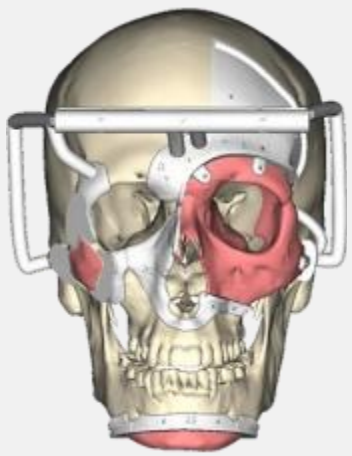




Imagery sourced from Lambert 2022. Sources: ARK Investment Management LLC, 2024, based on data from Shirouzu 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

3D打印在医学突破中发挥了作用

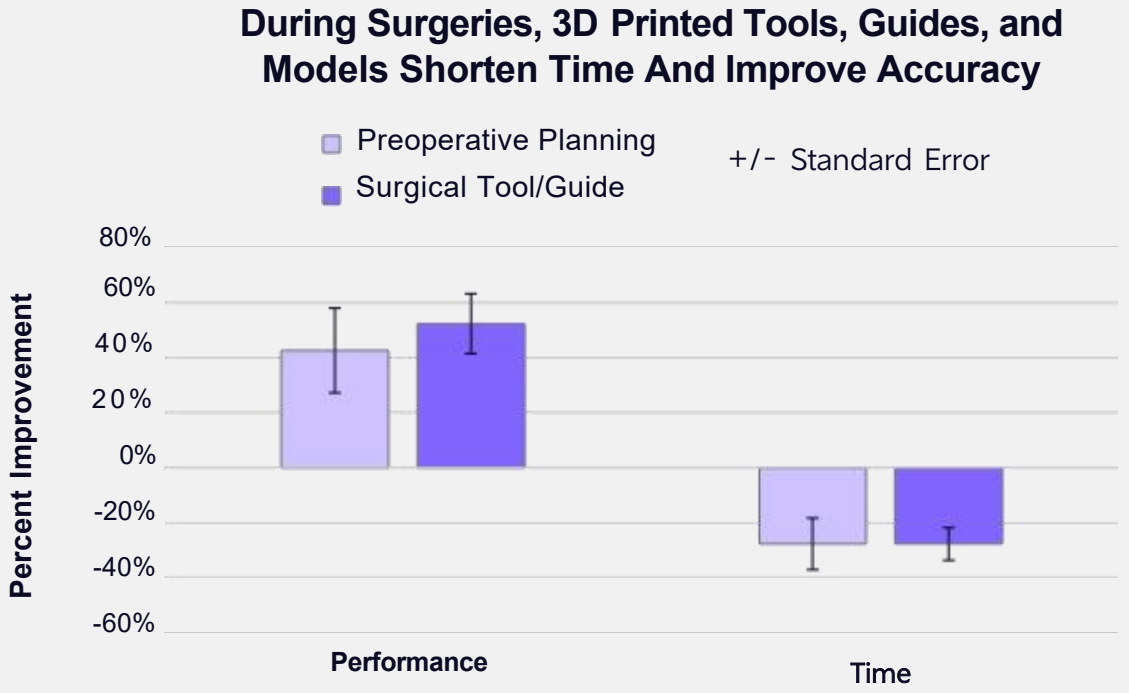
在确定捐赠者后不到24小时内，实现了3D打印的关键手术工具和指南，用于世界上第一个眼睛移植。



Donor

Patient

在一系列手术中，3D打印工具、指南和模型的性能提高了约40-50%，手术时间平均减少了约30%



Note: Time Savings and Accuracy Improvements Provided by 3D Printed Surgical Guides and Preoperative Planning Aides: bars represent the average percent improvement in time or performance as described in Bergmann et al. 2017 and Woodard et al. 2019, N=6-9 for each sample group. Error bars represent +/- standard error. The above analysis was conducted across medical fields; however, oral maxillofacial surgery and musculoskeletal studies were the most prevalent.

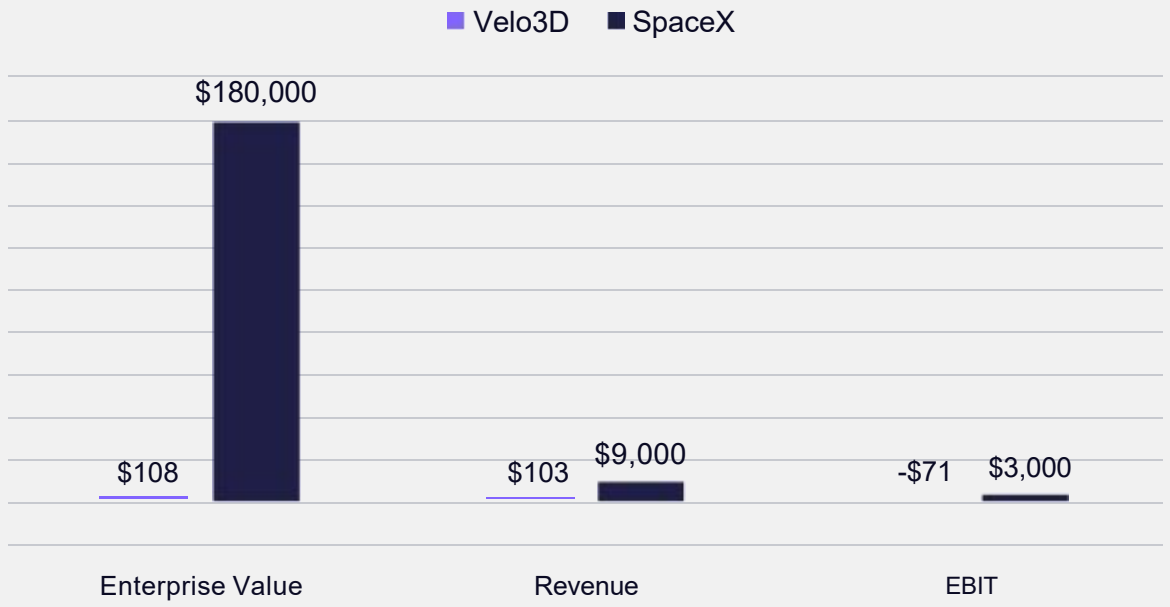
Sources: ARK Investment Management LLC, 2024. This ARK analysis is based on a range of underlying data from external sources, including Diment et al. 2017, Meara et al. 2015, and Dobson 2020 as of January 17, 2024, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

到目前为止，3D打印的用户比供应商受益更多

SpaceX每天使用3D打印为星际飞船的Raptor发动机制造零件。如今，SpaceX的发射和卫星业务的运营利润率优于任何3D打印供应商。

受益于3D打印的工业公司可以垂直整合以维持其竞争优势。

Velo3D And SpaceX
2023 Estimates In Thousands



A SpaceX Super Heavy Booster With 33 Raptor Engines:

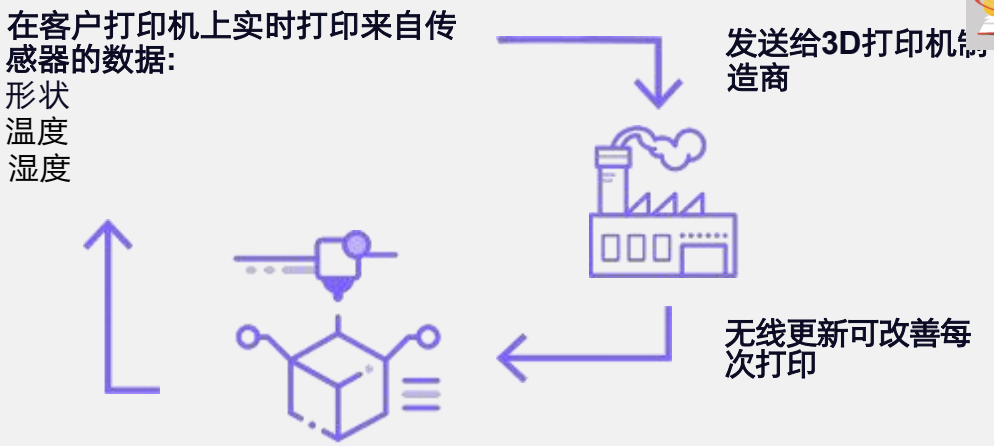
Velo3D is a 3D-printer manufacturer specializing in support-free powder bed fusion. Sources: ARK Investment Management LLC, 2024, based on data from S&P Capital IQ, 2024. SpaceX Heavy Booster Illustration sourced from Ali 2021. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

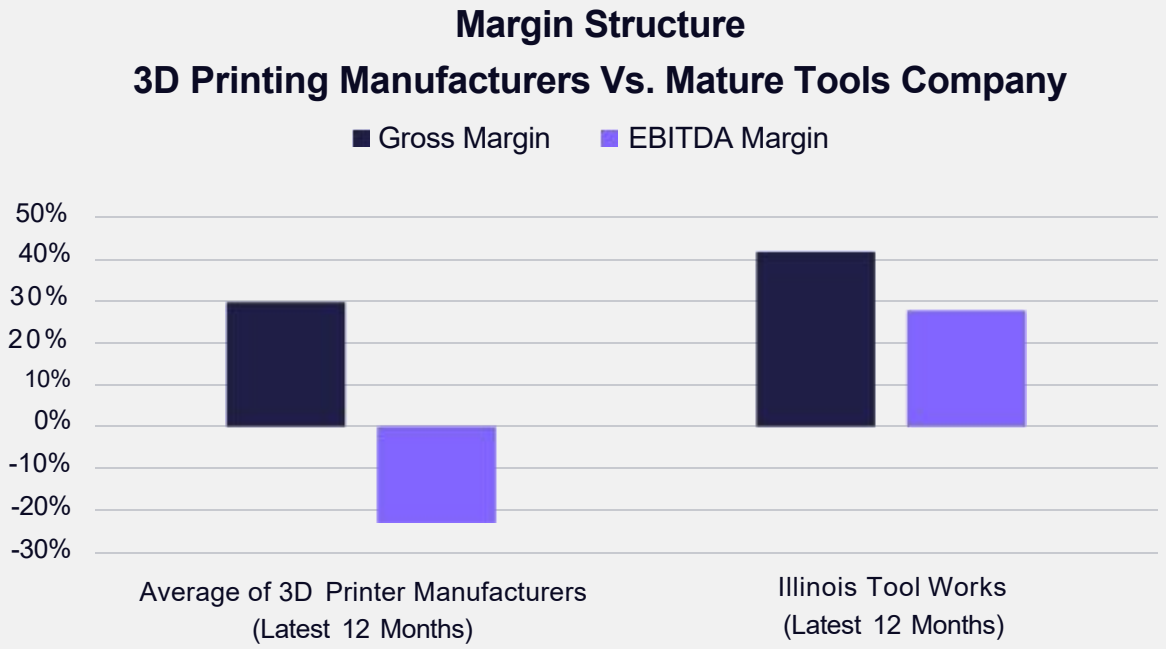
软件定义的3D打印机可以将一些经济效益转移回制造商

借助配备传感器的3D打印机，3D打印设备制造商可以从客户打印作业中收集数据，并通过无线方式更新来改善其在现场的打印机机队。

这种数据反馈循环可以帮助3D打印公司获得比现在更多的经济效益。

虽然公司可能不愿共享数据，但支持AI的制造解决方案会为3D打印设备公司及其客户创造更好的结果。





EBITDA: Earnings before interest, taxes, depreciation, and amortization. Sources: ARK Investment Management LLC, 2024, based on data from S&P Capital IQ, 2024. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

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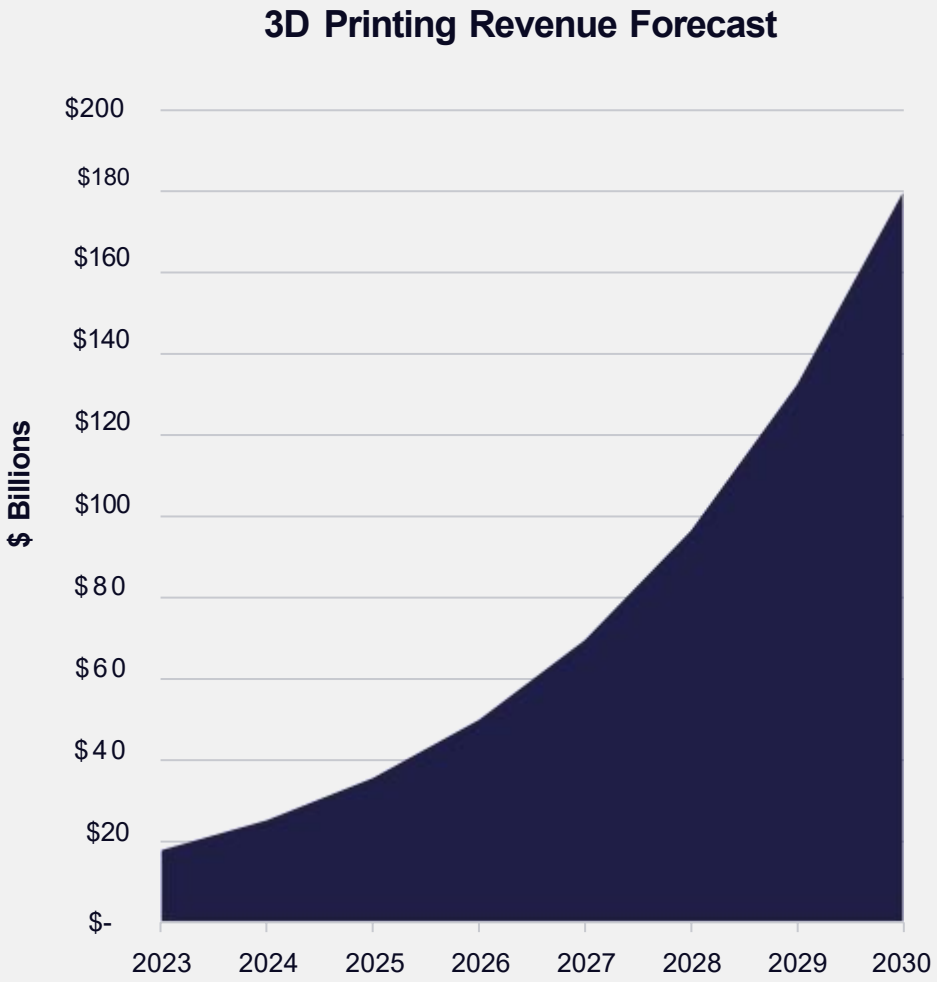
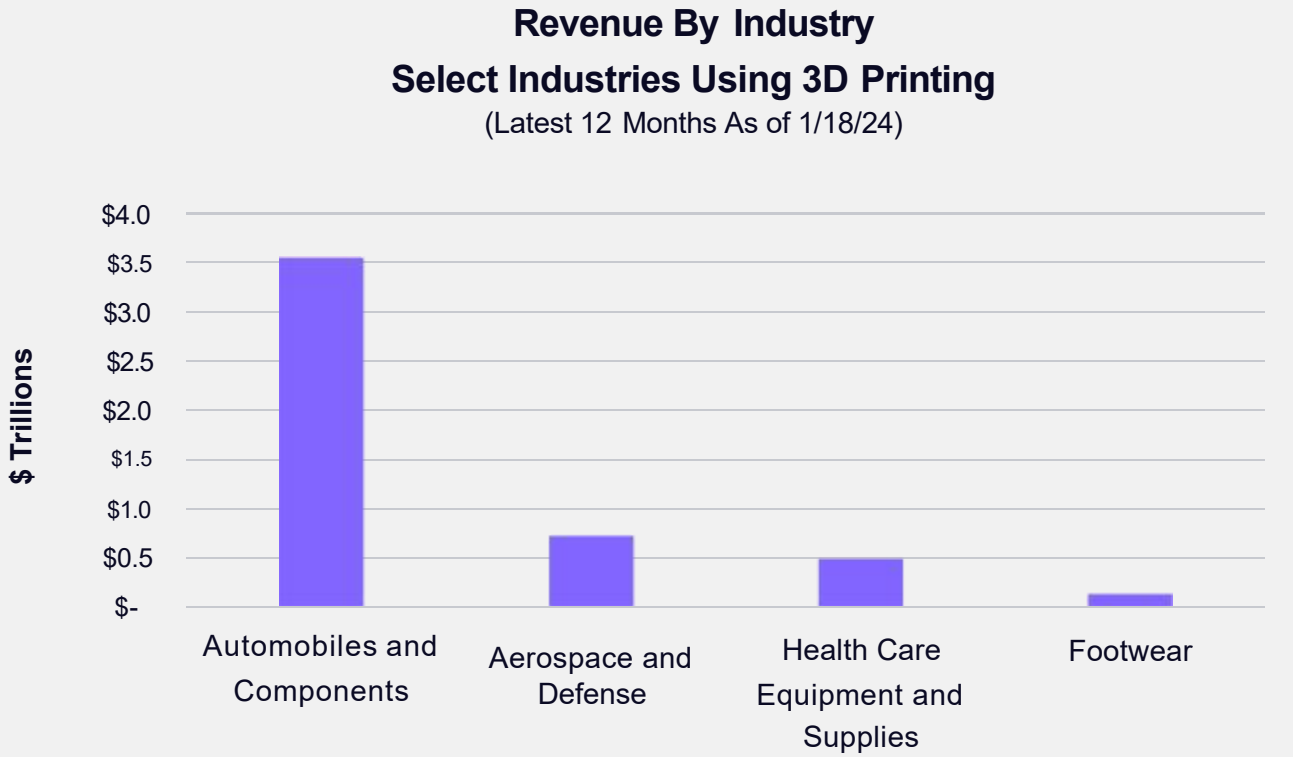
到2030年，3D打印收入可能会以每年40% 的速度增长到1800亿美元





Company Examples:				
	Tesla Volkswagen Ford General Motors BMW	SpaceX Lockheed Martin	Stryker Align	Nike Adidas

Note numbers are rounded. Sources: ARK Investment Management LLC, 2024 and S&P Capital IQ, 2024. This ARK analysis is based on a range of underlying data from external sources as of January 17, 2024, which may be provided upon request. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

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附录

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