THE INFINITE DEBT PROBLEM

HOW TO REPLACE PERPETUAL GROWTH WITH PRODUCTIVE PROSPERITY

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INTRODUCTION: The Chart That Changed Everything

In the spring of 2021, I found myself staring at two lines on a graph.

The first showed global obligations - government, corporate, and household - rising from roughly $50 trillion in 1980 to more than $300 trillion today. It traced an almost perfect exponential curve.

The second showed global resource extraction: the fossil fuels, minerals, biomass, and materials we pull from the planet each year. That line had also risen, but was beginning to flatten. In some categories - oil per capita, arable land per person, fresh water availability - it had already begun to decline.

Two lines. Two opposing stories.

The first said: **The future will be larger than the present.**

The second said: **The planet is not getting any bigger.**

The gap between those stories is the subject of this book. It is the infinite debt problem - and closing that gap may be one of the defining challenges of the twenty-first century.

The Contradiction at the Heart of Modern Finance

Here is the contradiction in one sentence:

We have built a financial system that makes promises about an unlimited future on a planet with limits.

This is not a moral or political argument. It is mathematical and physical, and it applies regardless of ideology, nationality, or optimism.

Consider a $100 loan at 5% annual interest. After 30 years it becomes $432. After 50 years, $1,147. After a century, more than $13,000. Compound interest does not rise gently; it follows an accelerating curve.

The physical world works differently. Every economic activity requires energy and materials, and every transformation generates waste. Earth is finite - not because environmentalists say so, but because physics says so. There is no law of compound expansion in nature. There is conservation of mass and energy, and an inexorable increase in entropy.

For two centuries, we were able to obscure this contradiction. We discovered fossil fuels - ancient sunlight stored in the Earth over hundreds of millions of years - and burned them at an accelerating rate. We opened new lands, found new resources, developed new technologies, and expanded the labour force.

Tomorrow was almost always larger than today.

But that era is ending.

The Unstated Assumption

Modern finance contains a powerful assumption that is rarely examined.

A government bond lends money today in exchange for a return tomorrow. A pension fund invests in assets whose valuations depend, at least partly, on future expansion. A mortgage is easier to service when income and property values rise.

The assumption is so deeply embedded that we treat it almost like gravity: permanent, natural, unavoidable.

It is none of those things.

It is a convention, developed under particular historical conditions. And conventions can be redesigned.

What This Book Is Not

This is not a book about the end of capitalism, the collapse of civilisation, or the superiority of one political ideology. I am not arguing that markets are evil, that debt must default, or that a dystopian future is inevitable.

The argument is narrower: one feature of modern finance - the assumption of perpetual growth embedded in fixed-rate sovereign debt - is becoming increasingly problematic.

The answer is not to abolish capitalism. It is to redesign one of its core instruments.

The Productivity Bond is neither left-wing nor right-wing. It is a market-based instrument that uses prices to align incentives. It rewards efficiency, innovation, and productivity; distributes gains broadly; and operates through market mechanisms.

The problem is the infinite debt problem.

The proposed solution is the Productivity Bond.

What This Book Is

This book is an invitation to understand how we got here, examine the mathematics and mechanics of the system, and consider a different way to finance the future.

The proposal is simple:

Instead of issuing bonds with fixed interest payments that accumulate regardless of economic performance, governments could issue bonds whose returns are linked to measurable improvements in efficiency.

A conventional government bond might promise 4% a year regardless of what happens to the economy. When the economy expands, that payment may be manageable. When it stagnates, the burden becomes heavier. When it contracts, the pressure can become severe.

A Productivity Bond changes that relationship.

Its return varies with measured efficiency gains. If productivity rises, the bond pays more. If productivity stagnates, it pays less. If productivity falls, it pays nothing in real terms.

The financial burden therefore moves with productive performance rather than being imposed independently of it.

The concept builds on existing instruments. Inflation-linked bonds have adjusted payments according to inflation for decades. GDP-linked bonds have been proposed and, in some cases, issued. The Productivity Bond adds another variable: productivity.

That distinction matters.

GDP can rise because we extract more resources, burn more fuel, increase population, or work longer hours. The economy becomes larger, but not necessarily better.

Productivity measures something different: how much value we create from the inputs we already have.

That is why productivity matters.

An economy can become more prosperous by becoming more efficient, innovative, and capable - not simply by consuming more.

What the Simulation Shows

This is not an abstract proposal. It has been modelled, stress-tested, and simulated.

The model generates 10,000 possible futures for a representative economy over 10 years. It incorporates GDP growth, productivity growth, inflation, employment, government revenue, spending, debt accumulation, recessions, booms, and AI-driven productivity shocks with varying effects on employment and revenue.

The results are significant.

Under realistic simulations that account for feedback between coupon payments and debt accumulation, the Productivity Bond reduces expected financing costs by approximately 3.1% compared with conventional debt. That result is robust across a range of calibrations.

Its effect on fiscal distress is more complicated. Higher payments during strong years can accelerate debt accumulation and, counterintuitively, increase distress probability. To address this, the model proposes a simple principal-adjustment mechanism.

A hybrid bond that combines productivity and revenue growth performs better: **11.8% lower cost, 25.9% lower distress probability, and 13.9% higher welfare.**

The simulation also identifies a critical variable: the government's ability to capture productivity gains.

If the government captures less than 15% of AI-driven productivity gains, the instrument barely outperforms conventional debt. Above 30%, the advantage becomes substantial.

That finding points to something larger than bond design. If future productivity gains are concentrated entirely in private hands, the public finances may capture too little of the benefit. A financial system tied to productivity therefore creates an incentive to ensure that technological gains are shared more broadly.

The Structure of This Book

The first twelve chapters present the core argument - the problem, the proposed instrument, and the path forward - in a tight, fast-moving narrative.

Chapters 13 through 22 provide the deeper historical and economic foundations. The appendices contain the mathematical framework, methodology, simulation results, legal design, implementation framework, investor materials, and source code.

A Note on the Numbers

This book contains numbers: trillions of dollars, basis points, expected returns, welfare estimates, and simulated probabilities.

I have tried to be transparent about their origins. Historical data comes from standard sources including the World Bank, IMF, BIS, and OECD. The simulation methodology is documented in the appendix, and the code is available for anyone who wants to reproduce or challenge the results.

The limitations matter.

A simulation is not a prediction. It depends on assumptions about AI shocks, government capture of gains, investor behaviour, and other uncertain variables. The results should therefore be read as evidence of potential, not a guarantee.

But the numbers are not the central argument.

The central argument is **architecture**: can we design financial instruments that reward productive improvement rather than requiring perpetual expansion?

The numbers test whether that architecture can work.

The Question This Book Answers

Let me return to the question that began this introduction:

How do we create a prosperous, stable civilisation without destroying the planet and without relying on infinite debt?

My answer is to redesign finance so that it rewards productive improvement rather than requiring ever-increasing output.

A productive economy can become richer without becoming infinitely larger. It can create more value from fewer inputs. It can improve wellbeing without proportionally increasing resource consumption.

Our financial system, however, often treats growth itself as the objective. It does not necessarily distinguish between expansion through innovation and expansion through extraction, efficiency and waste, or genuine improvement and environmental degradation.

The Productivity Bond is an attempt to change that incentive.

It links financial returns to measurable economic performance rather than simply to the passage of time and the mathematics of compound interest. It is a mechanism for making promises about the future that reflect what the economy actually achieves.

The goal is not an economy that becomes endlessly bigger.

It is an economy that becomes continuously better.

The Infinite Debt Problem is not an inevitability. It is an invitation to redesign finance for a finite planet.

The fully functional simulation used to generate the results in this book, including the figures in Appendix C, is freely available at https://traffictorch.github.io/productivity-bond-model/ under the MIT License. The repository contains the complete Python implementation, allowing readers to reproduce, fork, test, and improve the model.

Chapter 1: The Problem

The Unstated Assumption

First Let's talk about the elephant in the room. Actually, let's talk about the elephant that's been in the room for so long that we've built the room around it and forgotten it's an elephant.

Here is the contradiction at the heart of modern finance:

We have built a financial system that makes promises about an unlimited future on a planet with limits.

This is not a moral argument. It is mathematical and physical, and it applies regardless of ideology.

Consider the mechanics. A $100 obligation at 5% annual interest does not rise in a straight line. After 30 years, it reaches $432. After 50 years, $1,147. After a century, more than $13,000.

The physics is thermodynamics. Every economic activity requires energy and materials. Earth is finite. There is no law of compound expansion in nature - only conservation of mass and energy, and the inexorable increase of entropy.

For two centuries, we obscured this contradiction. We found fossil fuels - ancient sunlight stored over millions of years - and burned them at an accelerating rate. We opened new lands, discovered new resources, expanded the population, and built an economy in which tomorrow was almost always larger than today.

But that era is changing.

The assumption beneath the system - one we treat almost like gravity - is that tomorrow's economy will be larger than today's. Bonds, mortgages, pensions and other long-term financial claims are built around that expectation.

It is not a law of nature.

For most of human history, the idea that tomorrow would be materially larger than today would have seemed absurd. The Industrial Revolution changed that, powered in large part by abundant fossil energy. We built our financial architecture around the exceptional conditions that followed and gradually came to treat them as normal.

Now those conditions are changing.

The Four Walls

The great expansion rested on several pillars. I call the limits now closing around the twenty-first-century economy the **Four Walls**.

1. The Demographic Wall

For most of history, population growth expanded the labour force and helped drive economic activity. That engine is now reversing.

Birth rates are falling across much of the developed world and increasingly across the developing world. By mid-century, many countries are expected to have far more retirees relative to workers.

The demographic tailwind is becoming a headwind.

Japan - with decades of weak growth and debt exceeding 200% of GDP - is an early example of what happens when demographic momentum reverses.

2. The Productivity Wall

From the Industrial Revolution through much of the twentieth century, productivity growth was exceptionally strong. In recent decades, however, many advanced economies have experienced slower gains.

Despite the internet, smartphones and extraordinary technological advances, the productivity engine has not consistently matched the rates that characterised earlier periods.

The engine that powered expansion has lost some of its momentum.

3. The Resource Wall

The issue is not that the world is literally running out of fossil fuels. It is that the era of cheap, easily accessible resources is under increasing pressure.

The remaining deposits can require more energy, capital and environmental cost to extract. The same broader constraint applies to fresh water, fertile land and other essential inputs.

4. The Ecological Wall

Climate change is the most visible symptom, but it is not the only one.

Biodiversity loss, ocean acidification, and disrupted nitrogen and phosphorus cycles are connected expressions of an economy that has treated the planet as both an abundant resource and an unlimited sink for waste.

The planetary-boundaries framework identifies nine critical Earth-system processes, several of which are now considered to have crossed their safe boundaries.

These walls are not distant possibilities. They are converging.

Yet walls also define a space.

Within that space, something new can be built.

The Growth Trap

For two centuries, growth was treated as the answer to almost everything.

Debt grew too quickly? Grow the economy.

Pensions were underfunded? Grow the economy.

Inequality increased? Grow the economy.

Environmental damage mounted? Grow the economy.

Growth became the universal solvent.

That logic is now becoming a trap.

First, growth is not sufficient. Even sustained economic expansion does not eliminate the mathematics of compounding financial claims over long periods.

Second, growth is constrained. Demographic change, slower productivity gains, resource pressures and ecological limits make the conditions for perpetual expansion increasingly difficult.

Third, growth alone is not the objective. Economic activity can rise while inequality, instability or environmental damage also rise. What matters is not simply producing more, but producing greater value and wellbeing with sustainable use of resources.

GDP illustrates the problem. It measures economic activity, not whether that activity improves lives. Rebuilding after a disaster adds to GDP. So does military expenditure. Both represent spending, but neither automatically represents greater wellbeing.

The central problem is therefore not growth itself.

It is the assumption that **more must always be the answer**.

The physical constraints are closing in. But there is a wildcard: artificial intelligence.

AI could dramatically increase what we produce from the resources we already have. Or it could concentrate wealth, displace workers and weaken the link between employment and income.

Understanding that paradox is essential.

The AI Paradox

Artificial intelligence may be the most consequential productivity technology of our time. Like electricity or the steam engine, it is a general-purpose technology capable of transforming almost every sector.

But it has a crucial difference.

Previous technologies primarily amplified human labour. AI can automate significant amounts of cognitive work itself.

It can process information at extraordinary speed, automate analysis and decision-making, and potentially produce large productivity gains. Some estimates suggest AI could add 15–20% to global GDP over the next decade, although such forecasts are highly uncertain.

The opportunity is enormous.

So is the risk.

AI differs from earlier technological revolutions in several important ways:

- It automates cognitive as well as physical tasks.
- It is general-purpose, affecting almost every sector.
- Its capabilities can improve rapidly.
- Its deployment is heavily dependent on capital and computing infrastructure.
- Its development is concentrated among a relatively small number of companies.

If AI dramatically raises productivity while reducing employment, the traditional circulation of income could weaken.

Who has the purchasing power to buy what increasingly automated systems produce?

If ownership of the gains remains concentrated, inequality could widen sharply. If productivity creates abundance while prices and incomes fall, existing nominal debts could become harder to service.

AI could therefore strengthen the economy - or expose the weaknesses of a financial system built around continuously rising output and incomes.

The outcome depends partly on how its gains are distributed.

That is where the Productivity Bond and Productivity Dividend enter the story.

What If Debt Didn't Compound?

Imagine a financial system in which debt claims did not automatically grow simply because time passed.

A $100 obligation at 5% currently becomes larger regardless of whether the underlying economy improves. When incomes rise, the burden becomes easier to carry. When the economy stagnates, it becomes heavier. When it contracts, the same fixed obligation can become crushing.

The claim does not share the economy's risk.

What if it did?

Equity already provides one example. Shareholders participate in the performance of a company: they gain when it succeeds and lose when it fails. Inflation-linked and GDP-linked bonds move partway toward the same principle by tying payments to measurable economic conditions.

The Productivity Bond extends that logic to efficiency.

Its return is linked to improvements in productivity rather than an automatically accumulating fixed rate. The claim participates in economic progress instead of assuming it in advance.

The distinction is important.

The goal is not to eliminate returns to investors. It is to change what those returns depend on.

Instead of:

Time → Interest → Larger Debt

the logic becomes:

Productive Improvement → Shared Gain → Sustainable Return

Think of compound debt as a snowball rolling downhill: it grows simply because it is moving.

The alternative is a snowball attached to a rope. It moves when the economy creates genuine gains.

The rope is productivity.

This changes the relationship between borrower and lender. Risk and reward become more closely aligned. Financial obligations become more responsive to economic conditions. The incentive to pursue expansion for its own sake is reduced.

The idea is simple, but its implications are significant.

If financial claims can participate in genuine economic improvement without requiring perpetual expansion, we may be able to preserve the benefits of finance while removing one of its most powerful pressures.

That is the thought experiment.

The next chapter turns it into a financial instrument.

Chapter 2: Introducing the Productivity Bond

The Core Mechanism

The Productivity Bond is a sovereign debt instrument whose return is linked to measurable improvements in economic efficiency.

Instead of paying a fixed interest rate regardless of economic conditions, it adjusts its return according to productivity. The basic formula is:

$$c(t) = (1 + \pi(t)) \times (1 + min[max(\alpha \times g_N PI(t), F), C]) - 1$$

Where:

- **c(t)** = annual coupon payment
- **π(t)** = inflation (CPI)
- **g_NPI(t)** = growth of the National Productivity Index
- **α** = investor participation rate (e.g. 0.7)
- **F** = floor on real return (e.g. 0%)
- **C** = cap on real return (e.g. 5%)

In plain English: the holder receives inflation protection plus a capped share of productivity gains. The floor limits downside; the cap limits the government's exposure to exceptional gains.

Consider a $1,000 bond. If productivity rises by 3% and inflation is 2%, the coupon is approximately 4.8%. If productivity falls, the payment can fall to the inflation component alone. The investor therefore retains purchasing-power protection while participating in improvements in efficiency.

The mechanism is deliberately simple.

The National Productivity Index

The National Productivity Index (NPI) provides the underlying measure. It must be transparent, auditable, independently calculated, and resistant to political manipulation.

The proposed formula is:

$$NPI(t) = GDP(t)/[H(t)^{0}.40 \times E(t)^{0}.25 \times M(t)^{0}.20 \times K(t)^{0}.15]$$

Where:

- **H(t)** = total hours worked
- **E(t)** = primary energy consumption
- **M(t)** = raw material consumption
- **K(t)** = capital stock

The weights - 0.40, 0.25, 0.20 and 0.15 - approximate factor cost shares in developed economies over the past two decades. They remain fixed for the life of the bond. Sensitivity analysis in Appendix C indicates that the results remain robust to ±5 percentage-point changes in any individual weight.

The methodology is also **legally locked** into the bond's trust indenture. Neither the government nor the legislature can change the formula, data sources or payment rules during the bond's life.

An independent statistical agency publishes the NPI on a fixed schedule. Historical revisions do not alter coupons that have already been paid. After a specified finalisation period, each observation becomes final for payment purposes.

These safeguards are essential. A state-contingent bond is only credible if investors can trust the state variable on which its payments depend.

The NPI is designed to measure one thing: **how much economic value is produced from the resources used to produce it.**

It therefore rewards improvements in efficiency, technology, resource use and processes rather than simply more extraction, longer working hours or greater consumption.

The objective is not to make the economy bigger at any cost.

It is to make it better at producing value.

How the Bond Works

The structure is straightforward:

At issuance:
The government sells the bond to investors at a market-determined price and receives the proceeds.

Each year:
The NPI is calculated. Its annual change is applied to the coupon formula, and the resulting payment is made to investors.

At maturity:
The government repays the principal and retires the bond.

The principal remains fixed. The maturity is fixed. The coupon varies.

That distinction is the heart of the instrument.

A conventional bond resembles a fixed-rate loan: the payment remains largely independent of the borrower's economic circumstances. The Productivity Bond is closer to an income-sharing arrangement: payments rise when productive performance improves and fall when it weakens.

The Investor's Return

An investor's total return comes from two sources:

1. **The coupon**, which varies with inflation and productivity.
2. **Capital gain or loss**, determined by the market price of the bond.

The main difference from conventional sovereign debt is the first.

If productivity growth is weak, the coupon is lower. If productivity accelerates, it is higher. The floor limits the downside, while the cap limits the upside.

The result is a security designed to offer inflation protection and participation in productivity gains without the volatility of equity.

It is not intended to compete with high-growth assets for maximum returns. Its purpose is different: provide relatively stable income while linking investor rewards to improvements in the economy's productive capacity.

The Government's Cost

From the government's perspective, the coupon becomes a variable financing cost.

In strong periods, payments can increase alongside productive performance and, potentially, tax revenue.

In weak periods, payments decline, reducing pressure when public finances are already under strain.

This creates a potentially countercyclical structure.

During a recession, governments typically face falling revenue and rising demands for spending. A conventional bond continues paying its contractual coupon. A productivity-linked payment can decline instead.

The mechanism therefore shares some of the economy's risk between borrower and lender.

For institutional investors, this also creates a different risk profile from conventional sovereign debt. Its payments respond primarily to changes in productive capacity rather than simply to interest-rate movements or demand cycles. The proposed structure could therefore provide diversification for insurers, pension funds and other long-term investors.

The model estimates tracking error of approximately ±1.5% annually relative to a conventional sovereign benchmark and a potential Sharpe-ratio improvement of 0.2–0.3, although these figures are model outputs rather than guarantees.

The Floor and Cap

Two controls define the range of the variable return.

The floor sets the minimum real return, proposed at 0%. Investors therefore retain inflation protection even when productivity declines.

The cap limits the maximum real return, proposed at 5%. This prevents an extraordinary productivity surge from creating an unbounded financing cost for the government.

The trade-off is deliberate.

Investors accept limited upside in exchange for protection against severe downside. Governments accept a variable cost in exchange for protection against unlimited payouts.

Together, the two boundaries create a defined range within which the bond can respond to economic conditions.

The Countercyclical Property

The central attraction of the structure is its potential to move with economic capacity.

When productive performance improves, investors receive more.

When it deteriorates, the government's payment burden can decline.

That is the opposite of a rigid obligation that remains unchanged regardless of circumstances.

But there is an important qualification.

The Critical Caveat: The Feedback Loop

The simulation reveals a counterintuitive risk.

Under the model's realistic calibration, the Productivity Bond reduces expected financing costs by 3.1%, yet distress probability rises from 11.1% to 88.2%.

Why?

Because the bond can pay **more than conventional debt during strong years**. If the government finances those larger payments by borrowing, the debt stock grows faster. When a downturn arrives, the coupon falls - but it is now being applied to a larger stock of debt.

The apparent countercyclical benefit can therefore be undermined by debt accumulation during good times.

Think of it as a treadmill that speeds up when the weather is good. The government receives stronger economic conditions, but the resulting higher payments can cause it to borrow more. By the time conditions deteriorate, the debt burden may have become larger than before.

This is not a minor detail. It is the most important design problem identified by the simulation.

The proposed solution is a **Principal-Adjustment Mechanism**: automatic partial debt forgiveness during severe recessions, or a limit on debt accumulation linked to the NPI.

The purpose is to prevent higher payments in good years from creating a larger underlying liability that overwhelms the savings generated in bad years.

The Productivity Bond therefore should not simply be declared countercyclical because its coupon moves with productivity.

Its entire debt structure must be designed to preserve that property.

The detailed simulation and proposed mechanism are developed in Appendix C.

Comparison with Conventional Bonds

The Productivity Bond is not intended to replace conventional sovereign debt. It is an additional instrument that changes the way part of a government's liabilities respond to economic conditions.

Critics may point to earlier GDP-linked instruments, including UK and Argentine examples, which experienced liquidity problems and substantial pricing discounts.

The proposed design addresses two weaknesses in those structures:

1. **Data uncertainty:** the NPI methodology is locked and observations become final after a defined period, reducing the possibility of disputes arising from later revisions.
2. **Asymmetric downside:** the real-return floor provides investors with a defined minimum rather than exposing them to unlimited downside from weak economic performance.

Feature	Conventional Bond	Productivity Bond
Coupon	Fixed	Variable
Real return	Contractual	Linked to productivity, within limits
Debt service	Largely independent of productivity	Responds to productivity
Risk	Primarily borne by borrower	More widely shared
Cyclicality	Relatively rigid	Potentially countercyclical
Primary incentive	Financing	Productive improvement

The objective is not to eliminate conventional bonds.

Governments could issue both, using a diversified debt portfolio to balance predictability, liquidity and economic responsiveness.

The simulation suggests an illustrative mix of approximately **30% Productivity Bonds and 70% conventional bonds**, though the optimal allocation would depend on country-specific conditions and further testing.

The Simulation Results

The Productivity Bond's primary advantage in the model is lower expected financing cost - but that result comes with a critical qualification.

Under the baseline calibration - 10,000 simulated paths, a 10-year horizon and $\theta_{AI} = 0.30$ - expected financing cost falls from **0.5154 to 0.4994**, a reduction of approximately **3.1%**.

However, distress probability rises from **11.1% to 88.2%** in this particular calibration.

The reason is the feedback loop described above. Higher coupons during productive periods can increase debt service, requiring additional borrowing and enlarging the debt stock. The resulting liability can then outweigh the savings from lower payments during downturns.

This finding changes the proposal in an important way.

The Productivity Bond is not simply a fixed bond with a clever variable coupon.

It requires an accompanying mechanism that controls the accumulation of principal.

That is why the Principal-Adjustment Mechanism is not an optional refinement. It is part of the architecture.

The next chapter examines what happens when the gains generated by greater efficiency are treated not as a reason to demand ever more output, but as a **dividend of becoming better at using what we already have**.

Chapter 3: The Productivity Dividend

The Principle of Shared Prosperity

The Productivity Bond is only half of the architecture.

If technology and efficiency create more value with fewer inputs, the question is simple: **who receives the gains?**

The Productivity Dividend is the proposed answer.

It directs a portion of productivity-linked public revenue to citizens on a universal, per-capita basis. Investors receive returns for providing capital. Government receives additional fiscal capacity. Citizens receive a direct share of the gains generated by the productive economy.

The principle is straightforward:

When society becomes more productive, society should share in the benefit.

This is not charity. Productivity is not created by capital alone. Workers, consumers, infrastructure, education, public institutions, research and technological systems all contribute to the environment in which innovation becomes possible.

The dividend recognises that shared contribution.

It also differs from conventional welfare.

Welfare is generally designed to support people who meet particular eligibility conditions or fall below particular income thresholds. The Productivity Dividend is universal and unconditional. It is not a payment for being unemployed or poor. It is a citizen's share of collectively generated productive gains.

The Three-Way Split

The proposed system creates three primary beneficiaries.

1. Investors

Investors provide the capital and receive a return linked to productive performance, subject to the bond's floor and cap.

2. Government

Government receives tax revenue generated by stronger economic performance and gains a financing structure that can respond to productive conditions.

3. Citizens

Citizens receive a portion of productivity-linked public revenue through the dividend.

This creates a broader distribution mechanism than a system in which most gains from automation and technological improvement accrue primarily to asset owners.

The objective is not to eliminate private returns.

It is to ensure that the gains do not flow in only one direction.

The Dividend Formula

The proposed dividend is:

$$D(t) = \tau \times Revenue_Productivity(t)/Population(t)$$

Where:

- **D(t)** = dividend per citizen
- **τ** = share of productivity-linked revenue distributed

- **Revenue_Productivity(t)** = public revenue attributable to productivity gains
- **Population(t)** = eligible population

The dividend share, **τ**, is a policy choice.

A higher share produces larger payments but leaves less revenue available for other government purposes. A lower share provides smaller payments while retaining more fiscal capacity.

The payment is per capita. Every eligible citizen receives the same amount.

For example, suppose productivity-linked public revenue reaches $100 billion and the population is 50 million. With a 50% distribution rate, $50 billion would be distributed, producing a dividend of **$1,000 per citizen per year**, or roughly $83 per month.

It is not intended to replace wages.

It is intended to create a second channel through which productive gains reach households.

Where the Money Comes From

The dividend cannot simply be promised. It requires a reliable revenue base.

The proposed sources are mechanisms for capturing a portion of value created through technological and resource-efficiency gains.

AI Royalties

A small levy could be applied to value attributable to AI-generated economic activity.

One illustrative approach would be a 1% charge on GDP attributable to AI, although the precise base and rate would require detailed policy design.

The underlying principle is that AI depends on public infrastructure, education, research and accumulated social knowledge as well as private capital.

Productivity Taxes

A portion of productivity-attributable economic gains could be captured through taxation.

For example, a 5% levy on measured productivity-driven GDP growth could provide a direct link between the source of the gain and the revenue supporting the dividend.

Sovereign AI Equity

Government could hold equity stakes in strategically important AI companies or infrastructure.

Rather than relying entirely on taxation, the public sector could therefore participate directly in the financial returns generated by the technology.

Dividends from those holdings could contribute to the fund.

Resource-Efficiency Levies

Efficiency gains that reduce energy, material or waste costs could also generate public revenue through targeted levies.

The principle is consistent across all four mechanisms:

Capture a portion of the gain created by becoming more productive, then return part of it to the population.

These mechanisms are proposals, not assumptions about current tax systems. Their rates, legal structures and economic effects would require further modelling and policy testing.

The Critical Variable: Capturing the Gains

This is where the model's economics become especially important.

The government's ability to capture AI-driven productivity gains is one of the strongest determinants of whether the broader system works.

In the simulation, capturing **less than 15%** of AI-driven productivity gains leaves the Productivity Bond with little advantage over conventional debt.

Above **30%**, its performance improves substantially.

The precise thresholds are model-dependent, but the underlying lesson is robust:

Productivity gains only strengthen public finances if some of the gains reach the public sector.

This makes the revenue system as important as the bond itself.

If AI firms capture almost all of the economic surplus, productivity can rise dramatically without producing enough public revenue to support the dividend or strengthen government finances.

That is why capture mechanisms need to be established before technological concentration becomes entrenched.

The Impact on Citizens

The dividend creates an income stream that is independent of individual employment.

In normal conditions, it supplements wages and household income.

During downturns, it can provide additional purchasing power when employment and private income weaken.

During periods of rapid automation, it can help maintain household demand as some forms of labour become less valuable or disappear.

This does not mean the dividend would replace employment.

People would still work, create businesses, earn wages, invest and innovate.

The difference is that a portion of the value generated by increasingly automated production would also return directly to citizens.

If AI eliminates a job, the person who loses that job would not receive the dividend *because* they lost employment.

They would receive it because they are a participant in the economy that generated the productivity gain.

That distinction matters.

The AI Transition

Previous technological revolutions displaced particular occupations while creating new ones.

AI may do something broader because it can automate cognitive tasks as well as physical ones.

If productivity rises faster than new employment opportunities emerge, the traditional relationship between work and income could weaken.

The dividend provides one possible response.

Instead of asking every displaced worker to compete immediately for another source of labour income, part of the new productive surplus would already be circulating through households.

That could provide time to retrain, start businesses, move into new occupations or simply maintain consumption during the transition.

The objective is not to prevent technological change.

It is to ensure that technological progress does not destroy the purchasing power required to consume the abundance it creates.

The Impact on Inequality

A universal payment can reduce inequality because the same absolute amount represents a much larger share of income for a low-income household than for a wealthy one.

The effect can be measured using standard indicators such as the Gini coefficient, poverty rates and wealth concentration.

But the dividend is not a complete solution to inequality.

It does not change ownership of every asset. It does not eliminate differences in wages, property or investment returns. And its effect depends entirely on the size of the payment and the revenue available to fund it.

Its contribution is more specific:

It gives every citizen a direct claim on a portion of collectively generated productivity gains.

That can also strengthen social cohesion.

An economy in which technological gains are perceived as belonging exclusively to a small group of owners is politically fragile. An economy in which citizens visibly share those gains has a stronger social contract.

The Circular Flow

The dividend also has a macroeconomic function.

Households spend income.

Spending supports demand.

Demand supports production.

Production generates revenue and employment.

Employment generates additional income.

This circular flow is normally driven primarily by wages and private investment. If automation reduces the share of national income flowing through wages, another mechanism may become increasingly important.

The dividend provides one.

In that sense, it acts like a stabiliser for household purchasing power.

It does not create demand from nothing. It transfers part of the productive surplus into the hands of people who are likely to spend a significant proportion of it.

That can help maintain economic circulation during periods of technological disruption.

The Financial System

A stronger household income floor can also affect financial stability.

When households have more reliable income, they are better positioned to service mortgages, loans and other obligations. Maintaining consumption can reduce the severity of demand shocks. A more stable economy can, in turn, reduce stress across the financial system.

The dividend therefore complements the Productivity Bond.

The bond changes how part of government debt responds to productive performance.

The dividend changes how part of the resulting gains are distributed through society.

One addresses the **financing side**.

The other addresses the **distribution side**.

Together they form a broader architecture.

The Political Economy

The dividend has an unusual political characteristic: its underlying logic can appeal to very different traditions.

Progressives can see it as a mechanism for broadening the distribution of technological gains.

Market-oriented thinkers can see it as a property-rights or participation mechanism rather than a conventional welfare transfer.

Centrists can see it as an automatic stabiliser that supports demand and social stability.

But political support should not be assumed.

Questions about taxation, eligibility, government ownership, AI royalties and the size of the distribution would generate legitimate disagreement.

The strongest case for the dividend is therefore not that everyone will agree on it.

It is that the underlying principle is difficult to dismiss:

If technology allows society to produce substantially more with substantially less human labour, the resulting surplus cannot remain economically useful unless people retain purchasing power.

The dividend is one possible mechanism for maintaining that connection.

The Future of the Dividend

Implementation should begin cautiously.

A government could establish a dedicated productivity fund, define eligible revenue sources, publish the accounting methodology and begin with a small distribution.

The system could then be tested against actual productivity data, revenue collection, household behaviour and economic cycles.

If it worked, the mechanism could expand.

Over time, the dividend could become a permanent feature of an economy in which a growing share of production comes from automation, software, AI and highly productive capital.

The long-term vision is not a society in which nobody works.

It is a society in which **work is no longer the only route to participation in economic progress**.

That distinction becomes increasingly important as machines become capable of producing more of what society needs.

The Productivity Dividend is therefore more than a payment.

It is a proposed social contract for an economy in which productivity - not simply the expansion of labour and resource consumption - is the primary source of new prosperity.

The bond gives investors a claim on that improvement.

The government captures part of the resulting fiscal value.

The dividend gives citizens a share.

Three participants. One productive economy. Shared gains.

Chapter 4: No Infinite Compounding

The Problem of Exponential Growth

The fundamental problem with conventional debt is not interest itself. It is **compounding**.

At 5% annual interest, $100 becomes approximately $432 after 30 years, $1,147 after 50 years and more than $13,000 after a century. The underlying principal may be unchanged in a contractual sense, but when interest is capitalised, the financial claim grows exponentially.

That arithmetic creates a structural problem when liabilities persist for decades.

The economy, however, does not grow exponentially forever. Population, resources, energy and physical production all face constraints. When financial claims compound faster than the productive capacity supporting them, the gap eventually has to be closed through higher growth, inflation, taxation, restructuring or default.

This is the arithmetic at the centre of the infinite debt problem.

The proposed alternative is simple: **pay the return, don't compound it into the principal.**

A Productivity Bond has a fixed principal and a variable coupon. The coupon can change from year to year, but unpaid returns are not automatically added to the outstanding principal.

That distinction is fundamental.

What Does "No Compounding" Mean?

A common objection is immediate:

"But the bond still pays a return. Isn't that interest?"

Yes. The difference is what happens to that return.

With conventional compound debt, unpaid interest can become part of the debt itself:

$$Debt(t) = Principal \times (1 + r)^t$$

Under the proposed structure:

$$Debt(t) = Principal$$

The investor receives the annual coupon separately. The principal remains fixed until maturity.

This does not eliminate the government's obligation to make coupon payments. Nor does it make the bond risk-free. It simply prevents the outstanding principal from automatically generating an ever-larger claim.

That is the mechanism that matters.

The Cap

The cap limits the maximum real return paid in any period.

In the standard model, the real-return cap is **5%**. If productivity rises dramatically, the investor participates in the improvement, but only up to the agreed ceiling.

The exact level would be determined at issuance and fixed in the bond's legal terms. A range of roughly 3–7% could be considered depending on market conditions and the required investor return.

The cap serves two purposes.

For investors, it defines the maximum participation they are purchasing.

For government, it prevents an extraordinary productivity boom from producing an equally extraordinary debt-service obligation.

The principle is simple: **investors receive meaningful participation in upside without obtaining an unlimited claim on future productive gains.**

The Floor

The floor works in the opposite direction.

In the standard model, the real return cannot fall below **0%**. If productivity declines sharply, the coupon can fall to inflation alone rather than becoming negative in real terms.

This provides a degree of protection for investors such as pension funds, insurers and conservative institutional portfolios.

The floor is fixed in the bond's terms and cannot subsequently be altered by the issuing government.

Together, the cap and floor establish a defined range within which the variable return can move.

The Asymmetric Structure

The architecture is deliberately asymmetric:

- **The cap limits government exposure to exceptional upside.**
- **The floor limits investor exposure to downside.**
- **The variable component allows both sides to participate in changing economic conditions.**
- **The fixed principal prevents the claim itself from compounding indefinitely.**

This creates a different relationship between borrower and lender.

A conventional fixed-rate bond gives the investor a predetermined claim regardless of the economy's performance. The government carries most of the economic risk.

The proposed structure shares more of that risk while putting explicit limits on both sides.

It is not risk elimination.

It is **risk redesign**.

Conventional Debt vs the Alternative

Consider a $1,000 obligation at 4%.

If interest is compounded into the principal, the balance becomes approximately:

- **10 years:** $1,480
- **20 years:** $2,191
- **30 years:** $3,243

Under a non-compounding structure, the principal remains **$1,000**. The investor receives whatever annual coupon is specified, but the coupon does not automatically become additional principal.

That distinction becomes increasingly important over long periods.

A 30-year financial claim does not become a 30-year exponential claim.

The Mathematical Difference

The comparison can be expressed in its simplest form.

Conventional compound debt:

$$Debt(t) = P(1 + r)^t$$

Non-compounding principal:

$$Debt(t) = P$$

The first equation has an exponential term.

The second does not.

This does not mean the government faces no future payments. It means those payments are not recursively added to the amount on which future payments are calculated.

That removes one of the most powerful mechanisms driving long-term debt accumulation.

Why This Matters for Stability

Financial stability depends partly on keeping obligations within the capacity of the economy to service them.

When liabilities compound automatically, periods of weak economic performance can become progressively more difficult. The government may respond by borrowing more, cutting expenditure, raising taxes or relying on stronger future growth.

A non-compounding structure does not solve every fiscal problem. Governments can still borrow too much, spend too much or issue coupons they cannot comfortably afford.

But it removes one automatic source of escalation.

The difference is important:

The debt does not grow simply because time passes.

That creates more predictable long-term liabilities and reduces the need to rely on ever-larger future output to support yesterday's obligations.

Why This Reduces the Growth Imperative

If debt compounds indefinitely, economic output must continually expand to keep the debt burden manageable.

A fixed principal changes that relationship.

The economy can become more productive without having to become proportionally larger simply to service an exponentially expanding financial claim.

This is the broader objective of the model:

Move the financial system from requiring expansion toward rewarding improvement.

An economy can become more efficient, innovative and capable without endlessly increasing its physical throughput.

That distinction becomes increasingly important as demographic, resource and ecological constraints tighten.

Distribution Rather Than Accumulation

Compounding also has distributional consequences.

Interest payments transfer income from borrowers to creditors. When those claims compound over long periods, financial wealth can accumulate increasingly among existing asset holders.

The alternative proposed here is not to eliminate private investment returns.

It is to place a ceiling on the real return from this particular sovereign instrument, while directing part of the wider productive surplus through the Productivity Dividend described in Chapter 3.

The result is a different flow:

Capital receives a return.
Government retains fiscal capacity.
Citizens share in productive gains.

The objective is to prevent financial claims from absorbing an ever-growing share of future prosperity simply because they were created in the past.

A Different Kind of Debt

The argument is not that conventional bonds should disappear.

Fixed-rate sovereign debt has important advantages: simplicity, liquidity, established markets and predictable payments. The proposed instrument is an additional option.

Governments could issue a mixture of conventional and productivity-linked debt, allowing the market to determine the appropriate balance.

The deeper proposition is that sovereign debt does not have to follow a single design.

A financial claim can be:

- fixed or variable;
- compounded or non-compounding;
- entirely borne by the borrower or partially linked to economic performance;
- designed around expansion or around productive improvement.

Once these choices are made explicit, the architecture of debt becomes something that can be redesigned rather than simply inherited.

The End of Automatic Escalation

The phrase **"no infinite compounding"** does not mean that debt disappears.

It means that debt no longer contains an automatic mechanism for becoming exponentially larger merely through the passage of time.

The principal remains fixed.

The return varies within defined limits.

Exceptional gains do not create unlimited obligations.

Weak performance does not automatically create a larger principal.

And the financial claim is tied more closely to the productive capacity of the economy that ultimately supports it.

That is the essential shift.

The question is no longer:

How much can the economy grow to keep servicing an ever-growing claim?

It becomes:

How can financial claims participate in prosperity without demanding that prosperity grow forever?

The Productivity Bond is one proposed answer.

It does not promise a perfect financial system. It does something more practical: it removes one of the most powerful sources of automatic exponential expansion and replaces it with a bounded, state-contingent return.

Debt can still exist. Returns can still exist. Investment can still be rewarded.

But the claim itself does not have to grow forever.

Chapter 5: Productivity Instead of Extraction

The Incentive Problem

The financial system is a system of rewards. It influences what investors fund, what companies produce, and what the economy becomes.

The problem is that many of its strongest incentives favour extraction and expansion rather than efficiency and long-term productivity. Conventional debt demands fixed returns regardless of how productive the underlying economy becomes. Growth remains the dominant measure of success. Short-term financial performance often takes priority over longer-term outcomes.

These incentives are not necessarily the result of bad intentions. They are built into the system.

If an activity produces the highest financial return, capital tends to flow toward it. If extraction produces a higher return than efficiency, investors have an incentive to extract. If expansion produces a higher return than improvement, companies have an incentive to expand.

The question, therefore, is not whether investors respond to incentives. They do.

The question is what the financial system rewards.

The Productivity Bond changes that signal. By linking returns to productivity rather than simply to the passage of time, it creates a financial incentive for efficiency, innovation and productive investment.

If we reward extraction, capital will flow toward extraction. If we reward productivity, capital has a reason to flow toward productivity.

That is the central idea.

The Current Incentives

The current system creates four broad incentives.

1. Extract rather than improve.

Resource extraction can generate substantial financial returns even when the underlying resource is finite. The financial reward is captured today while many of the environmental costs arrive later.

2. Grow rather than become more efficient.

GDP rewards increased economic activity, but increased activity does not necessarily mean increased efficiency. An economy can become larger while consuming more energy, materials and resources.

3. Prioritise the short term.

Financial markets often focus heavily on quarterly earnings and near-term returns. Long-term investments can therefore struggle to compete with activities that produce faster financial results.

4. Concentrate rather than distribute.

When the primary claim on economic gains belongs to capital, productivity improvements can become concentrated among asset owners rather than broadly shared.

These incentives are not inherently irrational. They are rational responses to the rules of the system.

Consider an investor choosing between an oil company returning 10% and a renewable-energy company returning 5%. Unless other factors intervene, the higher return is the obvious choice.

The investor does not have to be anti-environmental. The system has simply told them where the reward is.

The Productivity Bond changes that calculation.

The New Incentives

The Productivity Bond introduces a different signal into the financial system.

1. Produce rather than extract.

Investment that improves output from existing labour, energy, materials and capital contributes to productivity. Higher productivity increases the NPI and therefore increases the potential return on the bond.

2. Improve rather than simply expand.

A company does not need to become physically larger to create value. It can become more efficient, produce better goods, reduce waste or deliver more with fewer resources.

3. Think longer term.

Because the bond's return is linked to measured productivity, its performance is connected to the underlying economy rather than simply to a fixed financial claim.

4. Share rather than concentrate.

The Productivity Dividend provides a mechanism for distributing part of the gains broadly across the population.

The bond does not force investors or companies to behave differently. It changes the financial rewards attached to different outcomes.

That distinction matters.

Markets can remain markets. Investors can still choose where to put their money. Companies can still pursue profits. The difference is that productivity becomes a source of financial value in its own right.

The Investment Signal

Every financial instrument sends a signal.

A conventional bond says: lend money today and receive a defined financial return tomorrow.

The Productivity Bond adds another signal: **when the economy becomes more productive, investors participate in the improvement.**

That signal can influence capital allocation.

For investors, it creates an incentive to favour an economy capable of generating sustainable productivity gains.

For companies, it increases the financial value of efficiency, innovation and better use of resources.

For governments, it creates an incentive to support policies that improve the productive capacity of the economy.

The financial system therefore becomes more closely connected to the performance society actually wants.

Think of the financial system as a set of headlights. It illuminates the activities that generate financial returns. The Productivity Bond does not turn off the headlights. It changes where some of the light falls.

From Extraction to Productivity

The objective is not to eliminate extractive industries overnight. Resources will continue to be extracted, and conventional investments will continue to exist.

The objective is to change the direction of marginal investment.

Productive investment includes:

- efficiency improvements
- technological innovation
- renewable energy
- research and development

- education and skills
- circular production
- better infrastructure
- more efficient use of capital and materials

Extractive investment includes activities that generate returns primarily through increasing resource consumption, depletion or environmental damage.

As the financial rewards change, capital can gradually shift toward activities that create more value from fewer resources.

That transition would not happen overnight. Nor does it need to.

The power of an incentive is cumulative. If a productive investment becomes slightly more attractive than an extractive alternative, capital begins to move. As successful productive investments create further opportunities, the shift can reinforce itself.

The goal is not to command the economy from above.

It is to change what the market finds attractive.

The Role of the NPI

The NPI is the measurement system that makes this possible.

It measures how effectively the economy converts its inputs into output. In the model developed in this book, those inputs include labour, energy, materials and capital.

The NPI therefore provides a broader measure of productive efficiency than economic growth alone.

GDP asks:

How much did the economy produce?

The NPI asks:

How effectively did the economy produce it?

That distinction is crucial.

An economy can increase GDP by consuming more resources. But an economy that increases output while using fewer inputs is becoming more productive.

The Productivity Bond links part of its return to this improvement.

The NPI therefore acts as a signal connecting economic performance to financial returns.

It is the compass of the Productivity Bond: not because it dictates where capital must go, but because it changes the reward for where capital goes.

The Circular Economy

This also creates a natural connection with the circular economy.

A circular economy seeks to extract greater value from existing resources while reducing waste and unnecessary consumption. Products are designed to last longer, materials are reused, and resources remain productive for longer.

This is fundamentally a productivity problem.

The objective is not simply to recycle more. It is to create more value from the resources already available.

That makes circular production, efficiency and resource conservation potentially attractive areas for productive investment.

The Productivity Bond provides a financial mechanism that can reinforce this transition.

If an economy can produce more value from the same amount of labour, energy, materials and capital, its measured productivity improves.

The financial system then has a reason to recognise that improvement.

The Transition

Changing incentives does not transform an economy by itself.

Institutions, regulations, infrastructure, business practices and investor expectations all take time to change. The Productivity Bond is therefore designed as part of a broader transition rather than as a replacement for the entire financial system overnight.

The transition has three essential components.

The Productivity Bond changes the financial incentive.

The NPI measures whether productivity is actually improving.

The Productivity Dividend shares part of the resulting gains with citizens.

Together they create a feedback loop:

productivity improves → financial returns recognise the improvement → investment in productivity becomes more attractive → productivity improves further → gains are shared more broadly.

That is the foundation of the Productivity Economy.

The transition still requires political and institutional support. But it does not require abandoning markets. It requires giving markets a better signal.

The Future of Investment

The future of investment does not have to mean choosing between economic prosperity and environmental limits.

It can mean becoming better rather than simply becoming bigger.

The Productivity Bond is designed around that principle.

It rewards improvements in the productive efficiency of the economy. The NPI provides the measurement. The Productivity Dividend provides a mechanism for sharing the gains.

The result is a financial system that begins to reward what a finite economy actually needs: **more value from fewer resources.**

That is the shift from extraction to productivity.

And it changes the central question of investment.

Instead of asking only:

How much can the economy grow?

we can also ask:

How much better can the economy become?

Chapter 6: The AI Dividend

The AI Value Creation

Artificial intelligence is already creating enormous economic value. It can increase productivity, reduce costs, automate tasks, accelerate research and generate entirely new products and services.

But the gains are not automatically distributed.

The companies that develop and deploy AI capture much of the direct financial value. Their shareholders, executives and investors can benefit substantially, while workers whose jobs or bargaining power are affected may receive far less of the upside.

That creates a problem.

If AI dramatically increases productivity while the gains become concentrated among a relatively small group of owners, the economy can become more productive without becoming broadly more prosperous.

The **AI Dividend** is designed to address that gap.

Its purpose is simple: **when AI increases the productive capacity of the economy, citizens should share in part of the value created.**

This is not an argument against private ownership or technological progress. It is an argument for ensuring that technological progress strengthens the economy as a whole rather than concentrating its benefits indefinitely.

Why Share the Value?

The case for sharing AI-generated value rests on several factors.

First, AI builds on decades of public investment in science, education, computing and digital infrastructure.

Second, much of the knowledge underlying modern AI emerged from publicly funded research and accumulated scientific work.

Third, AI systems rely on enormous quantities of data generated through human activity and increasingly collected from the wider economy.

Fourth, AI can change the distribution of income by reducing demand for some forms of labour while increasing the returns to capital and highly specialised skills.

Finally, the concentration of advanced AI capabilities can create economic and political risks if the benefits become excessively concentrated.

None of this means that the public owns every AI company or that every AI profit should be taxed away.

It means that **a portion of the new value created by AI can be treated as a shared economic dividend.**

The principle already exists in other contexts: when a society benefits from a valuable shared resource, it can choose to capture part of that value and distribute the proceeds.

The AI Dividend Mechanism

The AI Dividend is a per-capita distribution funded by AI-related public revenue.

The basic formula is:

$$AI_Dividend(t) = \frac{\tau_{AI} \times AI_Revenue(t)}{Population(t)}$$

Where:

- **AI Dividend(t)** = dividend received per citizen

- **τAI** = the share of AI-related revenue allocated to the dividend
- **AI Revenue(t)** = public revenue generated from AI-related sources
- **Population(t)** = eligible population

For illustration, suppose AI-related public revenue reaches **$50 billion**, the dividend share is **20%**, and the population is **50 million**.

The dividend pool would be $10 billion.

That would produce:

$200 per citizen per year, or approximately **$17 per month**.

The amount is deliberately tied to the performance of the AI economy. If AI generates more public revenue, the dividend grows. If it generates less, the dividend falls.

The mechanism therefore does not require government to promise a permanently fixed payment regardless of economic conditions.

Funding the Dividend

The AI Dividend could draw from several sources.

AI Royalties

A royalty could apply to revenue generated by certain AI-powered products and services.

The purpose would not simply be to raise revenue. It would recognise that AI commercialisation builds on public infrastructure, accumulated knowledge and data generated throughout society.

AI Profit Taxes

Governments could capture a portion of the profits generated by highly profitable AI businesses through existing corporate taxation or specifically designed AI-related tax mechanisms.

The important distinction is that the dividend would be funded by the economic gains generated by AI, rather than by ordinary household income.

Sovereign AI Equity

Governments could acquire equity stakes in strategically important AI infrastructure or companies.

Rather than relying entirely on taxation, the state could participate directly in the financial upside.

Dividends from those investments could then contribute to the public dividend.

Data Dividends

Where commercially valuable data is generated collectively or through publicly supported systems, mechanisms could be developed to return part of its value to the public.

The exact implementation would require careful legal and institutional design. Data ownership is complex, and not all data has the same economic or privacy characteristics.

The broader principle is straightforward:

If public resources help create private AI value, some mechanism should allow the public to participate in that value.

Distribution

The AI Dividend is designed to be universal and unconditional.

Every eligible citizen receives the same basic payment. It is not tied to employment, income or individual productivity.

It can be paid monthly, quarterly or annually, depending on the administrative system.

The distribution should also be transparent. Citizens should be able to see:

- how much AI-related revenue was collected
- how much was allocated to the dividend
- how the calculation was made
- how much each citizen received

Transparency matters because the dividend is not merely a payment mechanism. It is part of the social contract surrounding technological progress.

AI and the Circular Flow

The economic importance of the dividend extends beyond the payment itself.

A productive economy depends on a circular flow of income and spending.

Workers receive income and spend it. Businesses receive that spending as revenue. Revenue supports production, investment and employment, which generates further income.

AI can disrupt this cycle if productivity rises while the share of income flowing to labour falls significantly.

The AI Dividend provides another channel through which purchasing power can remain in circulation.

If automation allows the economy to produce more with fewer workers, part of the resulting economic value can be returned to citizens.

Citizens spend that income.

That spending supports demand.

Demand supports businesses.

Businesses continue investing in productive capacity.

The dividend therefore becomes more than a transfer. It can act as part of the mechanism that keeps the economic circulation functioning as the relationship between labour and production changes.

The Impact on Citizens

The AI Dividend provides a source of income that is not entirely dependent on employment.

For workers whose roles are transformed or displaced by automation, it provides an additional buffer while they retrain or move into new forms of work.

For people who remain employed, it provides supplementary income.

During downturns, it can continue supporting household spending provided the underlying revenue stream remains resilient.

The dividend is not intended to replace wages, employment or public services.

It is a complement.

Its purpose is to ensure that rising productivity does not automatically mean that the gains from productivity become increasingly detached from the population that ultimately creates, supports and consumes the resulting economic output.

The Distributional Effect

The AI Dividend can also reduce inequality.

A universal payment represents a larger share of income for a low-income household than for a high-income household. The same nominal dividend therefore has a progressive distributional effect even when every citizen receives exactly the same amount.

It can also reduce the concentration of gains from technological progress.

Without a distribution mechanism, AI productivity gains can flow disproportionately toward capital owners.

With a dividend, part of those gains flows back into the wider population.

The dividend is not a complete solution to inequality. Tax policy, education, competition, wages and ownership structures will continue to matter.

But it creates a direct connection between technological productivity and broad-based prosperity.

The AI Dividend and the Productivity Economy

The AI Dividend fits naturally into the broader architecture developed in this book.

The **NPI** measures improvements in productive efficiency.

The **Productivity Bond** links sovereign financing to those improvements.

The **Productivity Dividend** distributes a portion of productivity gains.

The **AI Dividend** extends the principle to the technological source of a growing share of future productivity.

AI is therefore not treated simply as a threat to employment or as a machine for generating private profits.

It becomes another source of productivity whose gains can be incorporated into the economic system.

This creates a simple principle:

If technology allows society to produce more with less human labour, society should share in the resulting productivity gain.

A New Relationship with Technology

The debate about AI is often framed as a choice between two extremes.

Either AI will create unprecedented prosperity, or it will destroy jobs and concentrate power.

The outcome is not predetermined.

Technology changes the economy, but institutions determine how the resulting gains are distributed.

If the financial and economic system rewards only ownership of AI capital, the gains can become highly concentrated.

If the system captures and distributes part of those gains, technological progress can support broader prosperity.

The AI Dividend is one mechanism for making that possible.

It does not stop automation.

It does not punish innovation.

It does not require governments to control AI.

It simply establishes a connection between **AI-generated value and public benefit**.

The Future of the AI Dividend

The AI Dividend could begin modestly.

Governments could test different revenue mechanisms, measure their effects and adjust the system as AI's economic role develops.

As AI-generated value increases, the dividend could increase with it.

Over time, the mechanism could become a normal component of the social contract: not a payment disconnected from economic performance, but a share of the new productive capacity created by technology.

That is the important distinction.

The goal is not to guarantee everyone a fixed income regardless of what happens in the economy.

The goal is to ensure that **when the economy becomes dramatically more productive because of AI, ordinary citizens participate in the upside.**

AI could therefore become one of the greatest productivity technologies in history without becoming one of the greatest engines of economic concentration.

The choice is institutional.

We can allow AI productivity gains to accumulate primarily as private wealth.

Or we can design a system in which a portion of those gains circulates back through society.

The AI Dividend is the second approach: **turning technological productivity into shared prosperity.**

Chapter 7: The Economy of Enough

The Vision

The Productivity Economy points toward an economy of enough: stable, sustainable, and equitable, where prosperity does not depend on continuously consuming more physical resources.

The economy of more is built around expansion. It assumes that output, consumption, and resource use can continue increasing indefinitely. On a finite planet, that creates an obvious problem: physical limits eventually constrain a system designed around endless expansion.

The economy of enough takes a different approach. It seeks prosperity through productivity - using resources more efficiently, reducing waste, improving quality, and creating more value from what we already have.

This is not an economy of deprivation. It is an economy of abundance achieved through efficiency rather than extraction, and through improvement rather than endless expansion.

The goal is simple: **get better without necessarily getting bigger.**

You might be thinking: *Isn't an economy of enough just another way of saying we have to accept less?*

No. It means having more of what actually improves life - health, education, leisure, connection, security, and purpose - without requiring ever more material consumption.

The Problem of More

The economy of more has delivered extraordinary gains. It helped create modern infrastructure, raise living standards, reduce poverty, and drive technological progress.

But it also created a structural dependency on continued expansion.

As economies grow, they consume resources and generate waste. Debt and financial commitments also become easier to sustain when future output is expected to be larger than today's. When growth slows, those assumptions become harder to maintain.

The problem is therefore not growth itself. Growth has been enormously valuable. The problem is treating perpetual growth as a permanent requirement.

The planet is finite. Resources are finite. Ecological systems have limits. A financial system that requires ever-increasing physical expansion eventually collides with those limits.

There is also a distribution problem. The gains from growth are not automatically shared equally, while the environmental costs can be widely distributed.

The economy of more can therefore become a treadmill: each period requires more expansion simply to maintain the assumptions of the previous one.

The economy of enough asks a different question:

What if prosperity came from improving the way we use what we have, rather than constantly requiring more of it?

The Solution of Enough

The Productivity Economy provides a framework for that transition.

Its objective is not to stop economic activity or innovation. It is to change what the financial system rewards.

Instead of rewarding expansion for its own sake, it rewards productivity: producing greater value with fewer resources, better technology, better organisation, and better use of capital.

This makes the economy more compatible with a finite planet.

It can also make it more equitable. If productivity gains are broadly shared through the Productivity Dividend, improvements in efficiency can translate into higher living standards rather than simply greater concentration of wealth.

And it can make the financial system more resilient. If sovereign financing is linked partly to productivity rather than simply fixed claims that compound regardless of economic conditions, debt can become more closely connected to the economy's capacity to generate value.

The economy of enough is therefore not a retreat from prosperity.

It is an attempt to redefine prosperity.

The Steady-State Economy

An economy of enough is compatible with a steady-state economy: one in which the physical scale of economic activity can stabilise while quality, efficiency, technology, and human wellbeing continue to improve.

Steady state does not mean stagnant.

A mature forest does not become valuable only by becoming physically larger. It becomes more complex, resilient, and productive within its ecological limits. An economy can work in a similar way.

Productivity can continue improving even when material throughput stabilises.

Technology can improve.

Healthcare can improve.

Education can improve.

Infrastructure can become more efficient.

Products can become more durable.

Services can become better.

People can gain more leisure and security.

The economy can therefore become **better rather than simply bigger**.

That distinction is central to the Productivity Economy.

The Role of Productivity

Productivity is the mechanism that makes an economy of enough possible.

Higher productivity means producing more value from a given quantity of labour, energy, materials, and capital. It can reduce resource intensity, reduce waste, improve quality, and create new forms of value.

Productivity is not simply about making people work harder. In many cases, the opposite is true. Better technology and organisation can allow the same output to be produced with less labour, less energy, or fewer materials.

That creates a choice.

The gains can be used to produce ever more physical output, or they can be used to improve living standards without proportionally increasing resource consumption.

The Productivity Economy chooses the second path wherever possible.

The objective is not maximum output. It is maximum useful value from limited resources.

The Role of the Productivity Bond

The Productivity Bond provides the financial mechanism for this model.

Conventional sovereign debt creates fixed obligations. The Productivity Bond links part of the return to changes in the economy's productivity, creating a closer relationship between the government's financial obligations and its productive capacity.

When productivity improves, investors participate in the gains.

When productivity weakens, the variable component of the return falls, subject to the bond's design parameters.

This creates a potentially useful countercyclical feature: the government's financing burden can become more closely aligned with economic performance.

The Productivity Bond therefore does not require perpetual economic expansion in the same way conventional fixed claims do. Its purpose is to align finance with improvement.

However, the simulation results discussed earlier reveal an important qualification: **variable coupons alone are not enough.** If higher payments in good years cause governments to borrow more and accumulate additional debt, the intended stabilising effect can be weakened or reversed.

The bond therefore requires safeguards, potentially including principal-adjustment mechanisms or limits on debt accumulation. The objective is not simply to make payments variable, but to ensure that the entire debt structure remains compatible with the economy's capacity to support it.

The Role of the Productivity Dividend

The Productivity Dividend provides the social mechanism.

Productivity gains do not automatically benefit everyone. Without a mechanism for distribution, they can accrue disproportionately to owners of capital, technology, and intellectual property.

The dividend creates a direct channel through which a portion of those gains can reach citizens.

It provides additional income regardless of employment status, allowing productivity improvements to translate into broader purchasing power and living standards.

This also supports the circular flow of the economy.

Productivity creates value. A portion of that value is distributed. Citizens spend part of the income. That spending supports demand for goods and services, which supports production and investment.

The dividend therefore connects productivity to participation.

The Circular Flow

The circular flow remains fundamental to the economy of enough.

In the traditional economy, wages provide much of the income that supports consumption. Businesses produce goods and services, workers receive wages, and those wages return to businesses through spending.

As automation and AI increase productivity, that relationship can weaken. An economy may be capable of producing more while requiring fewer workers to produce it.

The challenge is therefore not simply how to produce.

It is how to ensure that **purchasing power continues to circulate through the economy as production becomes increasingly automated.**

The Productivity Dividend provides one possible mechanism.

Productivity creates additional value. A portion is distributed to citizens. Citizens spend according to their needs and preferences. That demand supports businesses and services. The resulting activity creates further opportunities for investment and productivity improvement.

The cycle does not require perpetual increases in physical consumption. It requires continuing improvements in the way value is created and distributed.

The Transition

Moving toward an economy of enough would not happen overnight.

Existing institutions, financial markets, businesses, governments, and households are built around the current system. The transition therefore has to be gradual.

The Productivity Bond provides one part of the transition by introducing a new form of sovereign financing alongside conventional debt.

The Productivity Dividend provides another by creating a mechanism for sharing productivity gains.

The NPI provides the measurement framework needed to connect financial returns to measurable improvements in productivity.

Together, these mechanisms create the beginnings of a different economic architecture.

But the transition is ultimately a political choice. Institutions do not redesign themselves automatically. Governments, investors, businesses, and citizens must decide what outcomes they want the financial system to produce.

We already know how to build an economy of more.

The question is whether we can deliberately build an economy that becomes **better without needing to become infinitely larger.**

The Future of Prosperity

The future of prosperity does not have to mean choosing between economic stagnation and endless growth.

There is a third possibility.

An economy can continue to innovate, improve productivity, raise living standards, and create new forms of value while reducing its dependence on ever-increasing physical consumption.

That is the economy of enough.

The Productivity Economy provides the financial architecture for that possibility:

- **Productivity** provides the engine of improvement.
- **The Productivity Bond** aligns finance with productive capacity.
- **The Productivity Dividend** shares the gains.
- **The NPI** measures progress.
- **The circular flow** keeps value moving through the economy.
- **The steady-state framework** allows prosperity to continue without requiring perpetual physical expansion.

The objective is not to make humanity smaller.

It is to make our use of resources smarter, our financial commitments more realistic, and the gains from progress more broadly shared.

We do not need an economy that endlessly consumes more to prove that it is progressing.

We need an economy that keeps getting better.

Chapter 8: The First Productivity Bond

The Pilot Concept

The first Productivity Bond should begin as a pilot: a small-scale issuance designed to test the instrument, demonstrate its viability, and build market confidence.

It is not intended to transform a government's debt portfolio overnight. It is a proof of concept.

The pilot would be issued by a stable sovereign with credible institutions, a functioning financial market, and a reliable statistical agency. The issuance would represent only a small fraction of total government debt, limiting the consequences if the design needs to be adjusted.

The pilot would establish the essential parameters:

- a clearly defined National Productivity Index (NPI);
- a transparent coupon formula;
- defined floors and caps;
- an independent measurement process;
- a legal framework protecting investors;
- and clear rules governing revisions and payments.

Starting small is deliberate. A new financial instrument should earn trust through evidence rather than promises.

The Republic of Asteria

To demonstrate how the first issuance could work, consider the hypothetical Republic of Asteria.

Asteria is a small, stable advanced economy with:

- GDP of $250 billion;
- population of 5 million;
- government debt equal to 60% of GDP;
- a credible central bank;
- a reliable statistical agency;
- and access to established capital markets.

Asteria is not intended to represent a specific country. It is a model sovereign with the institutional characteristics required for a Productivity Bond pilot.

The purpose of the example is not to predict what any real government would do. It is to show how the instrument could operate in practice.

The NPI for Asteria

The NPI measures how efficiently the economy converts its major productive inputs into output.

For Asteria:

$$NPI(t) = \frac{GDP(t)}{H(t)^{0.40} \times E(t)^{0.25} \times M(t)^{0.20} \times K(t)^{0.15}}$$

Where:

- **H(t)** = total hours worked;
- **E(t)** = primary energy consumption;
- **M(t)** = raw material consumption;
- **K(t)** = capital stock.

The weights sum to 1.00 and remain fixed for the life of the bond.

The methodology would be specified in the bond prospectus and could not be altered unilaterally by the government. The NPI would be calculated by an independent statistical agency, with the underlying methodology and data publicly available.

For payment purposes, the annual NPI value would become final after a defined revision period. Subsequent statistical revisions would not retroactively change coupons already paid.

This is important because investors need a measurement system that is predictable as well as accurate.

The NPI does not require an entirely new statistical infrastructure. Its components are based on economic measures that governments already collect, including output, labour, energy, materials, and capital.

The Bond Design

The hypothetical Asteria pilot could have the following structure:

Feature	Specification
Issuer	Republic of Asteria
Principal	$1 billion
Maturity	10 years
Inflation reference	Asteria CPI
Real-return floor	0%
Real-return cap	5%
Payment	Annual
Principal	Repaid at maturity, subject to any specified adjustment mechanism
Currency	Asteria dollars
Credit	Sovereign

The illustrative coupon formula is:

$$c(t) = (1 + \pi(t)) \times \left[1 + \min\left(\max(0.7 \times g_{NPI}(t), 0\%), 5\,\%\right)\right] - 1$$

Where:

- $(\pi(t))$ = inflation;
- $(g_{NPI}(t))$ = annual NPI growth;
- 0.7 = the investor participation rate;
- 0% = the real-return floor;
- 5% = the real-return cap.

The basic idea is straightforward: investors receive inflation compensation plus a variable real return linked to productivity.

The bond is denominated in local currency, avoiding exchange-rate exposure for domestic investors. It would carry the sovereign's credit risk, just as conventional government debt does.

In broad terms, it would resemble an inflation-linked bond - except that part of the return is linked to productivity rather than simply inflation.

The Issuance

The pilot could be issued through a competitive government bond auction.

The government would announce the amount, maturity, coupon formula, and other terms. Investors would submit bids specifying the price and quantity they are willing to purchase.

The market would determine the issue price.

Initial investors would most likely be institutions familiar with sovereign debt and capable of evaluating a new instrument: pension funds, insurers, banks, asset managers, and sovereign investment funds.

The objective of the first auction would not be to maximise the amount raised.

It would be to establish a credible market price and demonstrate that investors are willing to hold the instrument.

A successful pilot would therefore provide evidence on three questions:

1. **Can the NPI be measured reliably?**
2. **Can the bond be priced and traded?**
3. **Do investors accept the relationship between productivity and returns?**

Those answers matter more than the size of the first issuance.

Pricing

Pricing would depend on expected productivity growth, inflation, sovereign credit risk, liquidity, and the uncertainty surrounding the variable coupon.

Suppose investors expect:

- inflation of 2% per year;
- NPI growth of 2% per year.

Under the illustrative 0.7 participation rate, the expected real productivity component would be:

$$0.7 \times 2\,\% = 1.4\,\%$$

The approximate expected nominal return would therefore be:

$$2\% + 1.4\,\% = 3.4\,\%$$

This is an illustration, not a guaranteed return.

The actual market price would depend on investor expectations and the risk premium required for the new instrument. A novel bond might initially trade below par because investors demand compensation for uncertainty and limited liquidity.

The market, rather than the government, would determine the appropriate price.

That is important. The Productivity Bond should not depend on an administratively imposed valuation. It should be tested by the same market forces that price other sovereign securities.

Performance Across the Cycle

The main advantage of the Productivity Bond becomes visible across different economic conditions.

A strong year

Suppose NPI growth is 3%.

The real productivity component would be:

$$0.7 \times 3\,\% = 2.1\,\%$$

With 2% inflation, the approximate nominal return would be 4.1%.

The government's payment is therefore higher during a period of strong productivity growth.

A weak year

Suppose NPI growth is 0%.

The real productivity component falls to 0%.

With 2% inflation, the approximate nominal return becomes 2%.

The government's variable financing burden therefore falls when productivity growth weakens.

This creates the intended countercyclical relationship:

stronger productivity → higher investor returns → higher government payments

weaker productivity → lower variable returns → lower government payments

The purpose is not to minimise payments every year. It is to make the government's financing obligations more closely aligned with economic performance.

An Important Design Problem

The pilot must also test an issue revealed by the simulation.

A variable coupon does not automatically guarantee fiscal stability.

In a strong year, higher productivity can produce a higher coupon. If the government finances those higher payments by issuing additional debt, the debt stock can increase. That larger debt stock can then generate higher future payments.

The result can create a feedback loop:

higher productivity → higher coupon → more borrowing → larger debt stock → higher future debt service.

If severe enough, this can undermine the countercyclical benefit of the instrument.

This is why the pilot should test not only the coupon formula but the complete debt architecture.

Possible safeguards include a principal-adjustment mechanism, limits on debt accumulation, or provisions that reduce outstanding principal during severe downturns.

The exact mechanism would need to be tested through further modelling and legal analysis. The important point is that **the Productivity Bond should not be judged solely by its coupon formula. Its entire balance-sheet effect must be considered.**

What the Pilot Needs to Prove

A successful pilot would establish evidence across several dimensions.

Measurement: The NPI can be calculated consistently, transparently, and independently.

Pricing: Investors can value the productivity-linked cash flows.

Liquidity: The bond can develop a functioning secondary market.

Fiscal performance: The variable coupon behaves as intended across different economic conditions.

Risk management: Safeguards prevent the bond from creating unintended debt feedback loops.

Investor demand: Institutional investors are willing to hold the instrument at market-determined prices.

These tests are more important than simply declaring the first issuance a success.

The Lessons

The first Productivity Bond should therefore be treated as an experiment in financial architecture, not as a finished product.

The pilot would show whether the NPI is robust enough to support a financial contract, whether investors accept productivity-linked returns, and whether the instrument genuinely improves the government's risk profile.

It would also reveal what needs to change.

That is the purpose of a pilot.

A financial instrument designed to operate for decades should not be expected to be perfect on its first day.

The Next Steps

If the pilot performs successfully, the government could expand the programme gradually.

Step 1: Increase issuance.
More Productivity Bonds are issued as existing debt matures and investor demand develops.

Step 2: Extend maturity.
The government introduces longer maturities, potentially moving from 10-year bonds toward 20- and 30-year instruments.

Step 3: Expand the investor base.
International institutions, pension funds, insurers, asset managers, and eventually retail investors gain access to the market.

Step 4: Develop the secondary market.
Greater trading activity improves liquidity and price discovery.

Step 5: Integrate the instrument into the debt portfolio.
Productivity Bonds become one component of a diversified sovereign financing strategy alongside conventional debt.

The objective is not to replace conventional bonds immediately.

It is to establish a credible alternative and allow the market to determine how large a role it should ultimately play.

The first Productivity Bond is therefore not the transformation itself.

It is the first piece of evidence that the transformation might work.

Chapter 9: The Transition

The Realistic Path

The transition to the Productivity Economy is not an overnight revolution. It is a gradual evolution in which existing debt remains in place while new forms of financing are introduced, tested, and expanded.

The realistic path is phased:

1. **Pilot** - test the Productivity Bond.
2. **Expansion** - increase issuance and develop the market.
3. **Integration** - make the bond a meaningful part of the debt portfolio.
4. **Transformation** - build the wider financial and social architecture around productivity.

Throughout the transition, conventional debt and Productivity Bonds coexist. Existing bonds are allowed to mature, while a growing share of replacement issuance takes the new form.

This approach avoids unnecessary disruption and allows governments and investors to learn from experience.

You might be thinking: *Why take 25 years? Why not change the system immediately?*

Because sovereign debt is measured in decades, not election cycles. Existing obligations cannot simply disappear. Markets need time to develop. Institutions need time to adapt. Investors need evidence.

The objective is therefore not to force a new system into existence.

It is to let a better system prove itself.

The Four Phases

Phase 1: The Pilot - Years 1–5

- **Initial issuance:** approximately $1 billion
- **Share of debt:** less than 1%
- **Purpose:** test the instrument and build confidence
- **Activities:** establish the NPI, legal framework, auction process, measurement system, and monitoring arrangements

The first phase is deliberately small. The priority is evidence, not scale.

Phase 2: The Expansion - Years 6–15

- **Issuance:** approximately $5–10 billion per year, depending on the sovereign's size and financing needs
- **Share of debt:** approximately 5–15%
- **Purpose:** build scale and develop the market
- **Activities:** increase issuance, extend maturities, expand the investor base, and develop secondary-market liquidity

At this stage, the bond moves from experiment toward established financial instrument.

Phase 3: The Integration - Years 16–25

- **Share of new issuance:** approximately 20–30%
- **Share of total debt:** approximately 15–30%
- **Purpose:** integrate Productivity Bonds into normal debt management

- **Activities:** optimise the portfolio, refine the instrument, and assess international applications

The bond is no longer an experiment. It becomes part of the sovereign's normal financing toolkit.

Phase 4: The Transformation - Year 26 onward

- **Share of new issuance:** approximately 30–50%
- **Share of total debt:** approximately 30–50%
- **Purpose:** establish the Productivity Bond as a major component of sovereign financing
- **Activities:** expand internationally, develop the broader Productivity Economy, and strengthen the Productivity Dividend

The percentages are targets, not rigid requirements. The appropriate mix would ultimately depend on market evidence, fiscal conditions, investor demand, and the performance of the instrument.

Coexistence with Conventional Debt

The transition does not require existing government debt to be converted.

Conventional bonds remain outstanding until maturity.

When they mature, the government can refinance them with a mixture of conventional and Productivity Bonds.

Over time, the composition of the debt portfolio changes.

This makes the transition gradual by design.

It also preserves diversification. There is no reason for a government to rely exclusively on one type of sovereign security.

The simulation presented earlier suggests that a portfolio containing approximately **30% Productivity Bonds and 70% conventional debt** can provide an attractive balance between risk and cost under the model's assumptions.

That should be treated as a modelling result, not a universal target. The optimal allocation would vary between countries and over time.

The important principle is diversification.

The Productivity Bond does not have to replace conventional debt to be useful.

The Rollover Strategy

The main mechanism for increasing the share of Productivity Bonds is debt rollover.

Governments routinely refinance maturing debt. Instead of replacing every maturing conventional bond with another conventional bond, a portion can be replaced with Productivity Bonds.

For example:

- Year 1: almost entirely conventional issuance
- Year 5: a small Productivity Bond allocation
- Year 10: a meaningful minority
- Year 20: a substantial portfolio allocation
- Year 25+: potentially 30–50%, depending on performance

No existing investor needs to be forced into the new instrument.

The new structure grows naturally as old obligations mature.

This is one of the most important features of the proposal because it makes the transition compatible with the existing financial system.

The Investor Base

The initial investor base would likely consist of institutions already accustomed to sovereign debt.

These could include:

- pension funds;
- insurance companies;
- banks;
- asset managers;
- sovereign wealth funds;
- other long-term institutional investors.

As the market develops, international investors and potentially retail investors could participate.

The expansion should follow demonstrated performance rather than political targets.

If the bond performs as intended, demand should grow. Greater demand increases liquidity. Greater liquidity improves price discovery. Better price discovery makes the instrument more attractive to additional investors.

The market can therefore develop through a reinforcing cycle:

performance → confidence → demand → liquidity → better pricing → broader adoption.

The Secondary Market

A functioning secondary market is essential.

Investors need to know that they can sell their bonds before maturity without facing excessive transaction costs.

As issuance grows, market makers and institutional investors can provide liquidity. Trading volumes can increase, bid-ask spreads can narrow, and prices can become more efficient.

The secondary market also provides an important source of information.

The market price reveals what investors collectively think about future productivity, inflation, sovereign risk, and the structure of the bond.

That makes the secondary market more than an exit mechanism.

It becomes a continuous test of whether the instrument is working.

The Legal Framework

The Productivity Bond requires a legal framework that protects both the sovereign and investors.

This framework would need to establish:

- the legal definition of the NPI;
- the independence and responsibilities of the statistical agency;
- the authority to issue Productivity Bonds;
- the precise contractual terms;
- treatment of statistical revisions;
- payment procedures;
- disclosure requirements;

- and dispute-resolution mechanisms.

The legal architecture does not need to be invented from scratch.

Governments already have extensive legal frameworks governing sovereign debt, inflation-linked securities, statistical agencies, and financial markets.

The Productivity Bond would build on those existing structures.

The innovation lies primarily in the variable to which part of the return is linked.

The Institutional Framework

The transition also requires credible institutions.

The Statistical Agency

The agency calculating the NPI must be independent, transparent, and professionally governed.

Its methodology must be published, auditable, and protected from political manipulation.

The Debt Management Office

The debt management office would issue and manage the bonds alongside conventional sovereign securities.

Its objective would remain the same: financing the government at an acceptable cost while managing risk.

The Regulatory System

Financial regulators would oversee trading, disclosure, market conduct, and investor protection.

The credibility of these institutions is critical because investors are ultimately buying a contractual promise based partly on an independently measured economic variable.

The Principal-Adjustment Problem

The transition must incorporate one lesson from the simulation.

A Productivity Bond can have a countercyclical coupon and still create fiscal stress if the underlying debt stock continues to accumulate.

The potential feedback loop is:

higher productivity → higher coupon payments → additional borrowing → larger debt stock → greater future debt service.

In that situation, the bond's apparent benefit during weak periods can be partly offset by debt accumulation during strong periods.

A principal-adjustment mechanism could help address this problem.

Possible designs include:

- partial principal reduction during severe recessions;
- a mechanism linking principal to the NPI;
- limits on debt accumulation;
- or other state-contingent adjustments.

The precise design requires further modelling and legal analysis.

The important lesson is that **countercyclical financing must be measured at the level of total debt, not merely annual interest payments.**

This safeguard should be incorporated into future versions of the Productivity Bond before large-scale adoption.

The Political Economy

The technical design is only half the challenge.

The transition would involve governments, investors, businesses, citizens, regulators, and international institutions - all with different interests.

Governments want affordable and reliable financing.

Investors want attractive risk-adjusted returns and enforceable contracts.

Citizens want the benefits of productivity to be broadly shared.

Businesses want predictable rules and access to capital.

Regulators want financial stability.

The proposal therefore needs a coalition broad enough to survive changes in governments and economic conditions.

Its strongest argument is practical rather than ideological:

the system should be tested, measured, and improved before it is scaled.

That makes the transition less about choosing sides and more about demonstrating whether the instrument actually works.

The Transition Complete

The transition is complete when Productivity Bonds become a significant component of sovereign debt without compromising financial stability.

A mature system could contain a diversified mix of conventional and Productivity Bonds, with the precise allocation determined by evidence and market conditions.

At that point, the broader benefits of the Productivity Economy can emerge:

- **Stability:** financing becomes more closely connected to economic performance.
- **Sustainability:** the financial system becomes less dependent on perpetual expansion.
- **Productivity:** investment is rewarded for improving economic efficiency.
- **Equity:** productivity gains can be shared through the Productivity Dividend.

The goal is not to eliminate conventional finance.

It is to add a financial instrument that better reflects the economy we are trying to build.

The transition therefore follows a simple principle:

Do not destroy the existing system. Build the alternative alongside it, test it, improve it, and let evidence determine how far it should go.

Chapter 10: The New Social Contract

The Old Social Contract

The old social contract was built around work and growth.

People worked. They earned wages. They paid taxes. Governments provided public services and social protection. As the economy grew, wages and living standards could rise alongside it.

For much of the industrial era, this arrangement worked remarkably well. It helped create the modern middle class, reduce poverty, and deliver extraordinary improvements in living standards.

But its foundations are becoming less secure.

Automation and artificial intelligence can increase output while reducing the amount of human labour required. Productivity can rise without wages rising proportionally. Meanwhile, slower population growth, resource constraints, and environmental limits make perpetual economic expansion increasingly difficult to assume.

The old contract therefore faces two pressures at once:

less certainty that everyone will have a traditional job, and less certainty that the economy can grow indefinitely.

The Productivity Economy requires a new social contract - one designed for an economy in which productivity can continue rising even when employment and material growth do not.

The Foundations of the New Social Contract

The new social contract rests on three principles.

1. Productivity, not perpetual growth

The objective is to improve the economy rather than simply expand it.

Efficiency, innovation, technology, and better use of resources become measures of progress alongside conventional economic output.

2. Sharing, not concentration

Productivity gains should not automatically flow only to the owners of capital and technology.

The Productivity Dividend provides a mechanism through which a portion of those gains can be distributed broadly.

3. Participation, not dependence

People should have the security to participate in society even when traditional employment becomes less reliable.

Participation can take many forms: paid work, entrepreneurship, education, caregiving, volunteering, creative activity, and civic contribution.

The new social contract therefore changes the question from:

"Do you have a job?"

to:

"How can you participate and contribute in a productive society?"

The Productivity Dividend

The Productivity Dividend is the financial foundation of this new arrangement.

It provides citizens with a share of the gains generated by increasing productivity. Unlike conventional welfare, it is universal rather than targeted only at people who meet particular income or employment conditions.

That distinction matters.

A universal dividend treats citizens as participants in the productive economy rather than recipients of charity.

It can provide three things.

Security: an additional source of income when employment is unstable.

Opportunity: greater freedom to retrain, study, start a business, care for family, or pursue other productive activities.

Dignity: recognition that the gains of technological and economic progress should be broadly shared.

The dividend does not replace work.

It changes the relationship between work and economic security.

As machines become more productive, society can choose to use some of the additional value they create to give people greater security rather than simply demanding more output from fewer workers.

The Productivity Bond

The Productivity Bond provides the financial foundation for the same social contract.

It links sovereign financing partly to productivity rather than relying entirely on fixed financial claims.

The objective is to align the interests of investors, governments, and the productive economy.

When productivity improves, investors participate in the gains.

When productivity weakens, the variable component of the government's financing burden can decline.

But, as the simulations showed, the design must prevent higher payments in good years from creating an accumulating debt burden. Principal-adjustment or debt-management safeguards may therefore be necessary.

The bond is not a social programme.

Its role is financial: to make sovereign debt more closely connected to the economy's capacity to generate value.

The Productivity Dividend then provides the mechanism through which a portion of that broader productivity gains can reach citizens.

Together, the two instruments connect **finance, productivity, and distribution**.

Education and Training

A new social contract cannot rely on income distribution alone.

People need the ability to participate in an economy that is changing rapidly.

Education therefore becomes more important, not less.

The education system should emphasise capabilities that complement increasingly capable machines:

- critical thinking;
- creativity;
- problem-solving;
- communication;
- collaboration;
- adaptability;
- and lifelong learning.

Training also needs to become more flexible.

In a rapidly changing economy, learning cannot end when formal education ends. People may need to change occupations, acquire new technical skills, or work alongside technologies that did not exist when they entered the workforce.

The principle is simple:

if technology changes continuously, education cannot remain a once-in-a-lifetime event.

The Productivity Dividend can provide part of the financial foundation that makes lifelong learning more practical.

Social Support

A stronger social contract still requires essential public services.

Income support alone cannot guarantee security.

Healthcare, housing, education, disability services, aged care, and other social services remain important components of a functioning society.

The Productivity Dividend should therefore complement - not automatically replace - existing social institutions.

Its purpose is to create a broad economic floor beneath citizens while public services provide the infrastructure needed for a productive and secure society.

The precise balance would depend on each country's existing institutions and fiscal capacity.

The Meaning of Participation

The transition to a productivity-driven economy also changes the meaning of work.

Paid employment will remain important. People will continue to want the income, purpose, relationships, achievement, and identity that work can provide.

But work may no longer be the only recognised form of economic contribution.

Caregiving creates value.

Volunteering creates value.

Education creates value.

Community participation creates value.

Entrepreneurship creates value.

Creative work creates value.

Citizenship creates value.

A society in which machines perform an increasing share of routine production has an opportunity to recognise these contributions more fully.

The objective is not to make people economically irrelevant.

It is to give people more freedom to decide **where their human effort creates the most value.**

The Role of Democracy

A new social contract cannot simply be designed by governments, corporations, or financial institutions and imposed on everyone else.

Its legitimacy must come from democratic institutions.

The governance of the Productivity Economy should therefore be:

- **transparent** in its measurements;

- **accountable** in its decisions;
- **independent** where technical integrity is required;
- and **democratic** where collective choices are being made.

This is particularly important for the NPI and the Productivity Dividend.

If productivity determines financial returns and public distributions, the measurement system must be trusted.

The statistical agency must therefore be protected from political manipulation, and its methodology must remain open to independent scrutiny.

Democracy is not an accessory to the Productivity Economy.

It is part of its infrastructure.

The Role of Trust

No financial system can function without trust.

Investors must trust the measurements.

Citizens must trust the distribution system.

Businesses must trust the rules.

Governments must trust the institutions administering the system.

That trust cannot simply be declared. It has to be earned through transparency, independent auditing, predictable rules, and consistent performance.

The Productivity Economy therefore requires institutional credibility as much as financial innovation.

A clever formula is not enough.

If people do not believe the number, they will not trust the bond.

If investors do not trust the contract, they will not buy it.

If citizens do not trust the distribution mechanism, they will not support it.

Trust is the connective tissue of the entire system.

The New Social Contract

The new social contract is built around a different relationship between technology, productivity, and prosperity.

The old model effectively says:

work → wages → consumption → growth → prosperity.

The emerging model can add another pathway:

productivity → shared gains → income → participation → prosperity.

Work remains part of the system, but it is no longer the only mechanism through which people participate in economic progress.

Technology can increase productivity.

The financial system can capture and measure part of that improvement.

The Productivity Dividend can distribute a portion of the gains.

Education and training can help people adapt.

Public services can provide the foundation for security.

Democratic institutions can ensure that the system remains accountable.

That is the new social contract.

It does not promise that everyone will receive the same outcome.

It promises something more fundamental:

that progress should not leave people behind simply because the machines became better at producing.

The Productivity Economy is therefore not just a new way of financing government debt.

It is a proposal for a different relationship between productivity and society - one in which technological progress can create greater security, greater opportunity, and greater freedom rather than simply greater concentration of wealth.

The old social contract was built for an economy where human labour was the primary source of production.

The new one must be built for an economy where **human intelligence and machine intelligence increasingly work together to create value.**

And the central question is no longer whether technology will make us more productive.

It is:

What will we do with the productivity it creates?

Chapter 11: The Roadmap

The Vision and the Path

The vision of the Productivity Economy is straightforward: an economy that is stable, sustainable, and equitable; one that rewards productivity rather than requiring perpetual growth; shares the gains of progress; and operates within the physical limits of the planet.

The challenge is turning that vision into something practical.

The transition does not begin with replacing the entire financial system. It begins with measurement, experimentation, and evidence. The NPI must be developed. The Productivity Bond must be tested. The market must be allowed to evaluate it. Successful elements can then be expanded.

The roadmap is therefore deliberately incremental.

Measure. Test. Expand. Integrate. Transform.

Step 1: Statistical Reform

Before productivity can become the basis of a financial instrument, it must be measured reliably.

The first task is to establish the NPI as a transparent and independently governed measure of productive efficiency.

Action 1.1: Define the NPI

The methodology must specify:

- the inputs included;
- the output measure;
- the weighting system;
- the treatment of revisions;
- the calculation period;
- and the publication schedule.

The methodology should be fixed sufficiently to prevent governments from changing the measure simply because the results are inconvenient.

Action 1.2: Establish independent governance

The statistical agency responsible for the NPI must have operational independence, adequate resources, and clear legal obligations.

Its calculations should be subject to independent review and audit.

Action 1.3: Implement the index

The agency begins publishing the NPI using existing economic data wherever possible.

The index should be published regularly, with its underlying methodology and relevant data available for scrutiny.

Action 1.4: Test and audit

Before the NPI is used to determine financial payments, it should be tested against historical data and independently audited.

Timeline: approximately 1–2 years.

The principle is simple:

You cannot build a financial system around a variable you cannot measure reliably.

Step 2: The Pilot

Once the statistical framework is established, the first Productivity Bond can be issued.

The pilot should be deliberately small. Its purpose is to test the instrument rather than solve the government's debt problem.

Action 2.1: Design the bond

The government establishes:

- principal;
- maturity;
- coupon formula;
- inflation treatment;
- productivity participation rate;
- floor and cap;
- payment schedule;
- and any principal-adjustment mechanism.

Action 2.2: Establish the legal framework

The legislation and prospectus must define the rights and obligations of both the government and investors.

The treatment of statistical revisions and disputes must be explicit.

Action 2.3: Issue the bond

The bond is sold through a competitive market process.

The government does not need to prove that the instrument is universally accepted. It only needs to establish whether qualified investors are willing to buy it at a sustainable price.

Action 2.4: Monitor performance

The pilot should be evaluated against clear criteria:

- measurement reliability;
- investor demand;
- pricing;
- liquidity;
- fiscal performance;
- and behaviour across different economic conditions.

Timeline: approximately 2–3 years.

The pilot is not a failure if the design needs changing.

That is precisely what a pilot is for.

Step 3: The Expansion

If the pilot demonstrates that the instrument is viable, issuance can increase gradually.

Action 3.1: Increase issuance

Productivity Bonds become a larger part of new government borrowing.

The increase should follow investor demand and demonstrated performance rather than an arbitrary political target.

Action 3.2: Extend maturity

Once shorter-term instruments are established, longer maturities can be introduced.

Twenty- and thirty-year bonds could eventually allow governments and investors to develop a longer-term market around productivity-linked financing.

Action 3.3: Expand the investor base

As confidence grows, the investor base can expand from specialist institutional investors to a broader range of domestic and international participants.

Action 3.4: Develop the secondary market

Greater issuance should support greater liquidity.

Market makers, institutional investors, and other participants can provide the trading activity required to establish reliable secondary-market pricing.

Timeline: approximately 5–10 years.

The purpose of this phase is scale.

The Productivity Bond moves from an experiment to a functioning market.

Step 4: Integration

Once the market has sufficient depth and evidence has accumulated, Productivity Bonds can become a normal component of sovereign debt management.

Action 4.1: Optimise the portfolio

Governments can determine the appropriate mix of conventional and Productivity Bonds according to cost, risk, liquidity, and fiscal conditions.

The simulation in this book suggests that an allocation around **30% Productivity Bonds and 70% conventional debt** can be attractive under the model's assumptions.

That is not a universal prescription. The appropriate allocation would need to be determined empirically for each sovereign.

Action 4.2: Refine the design

The bond should evolve as evidence accumulates.

If the simulations and pilot reveal weaknesses - particularly around debt accumulation and principal dynamics - the instrument should be modified before being scaled further.

Action 4.3: Explore international applications

Once several countries have experience with productivity-linked debt, an international framework could be explored.

This could eventually include a **Global Productivity Index** or comparable internationally consistent measures.

But international adoption should come after domestic evidence, not before it.

Action 4.4: Build the social architecture

The financial transition can then be connected to the broader Productivity Economy.

This includes developing the Productivity Dividend, strengthening lifelong learning, adapting social support, and ensuring that productivity gains are broadly distributed.

Timeline: approximately 10–15 years.

Integration is where the financial innovation becomes part of the wider economic system.

Step 5: Transformation

The final stage is not the elimination of conventional finance.

It is the establishment of a mature financial system in which productivity-linked financing is a significant and proven component.

Action 5.1: Complete the transition

The share of Productivity Bonds can increase as existing debt matures and market evidence supports further issuance.

Action 5.2: Measure the results

The system should be judged against measurable outcomes:

- financing costs;
- fiscal distress;
- debt sustainability;
- productivity;
- inequality;
- and economic resilience.

If the results do not match the objectives, the system should be adjusted.

Action 5.3: Develop the international architecture

If Productivity Bonds prove successful across multiple countries, they could eventually become part of international capital markets.

A common productivity framework could support cross-border investment and potentially create new classes of sovereign assets.

Action 5.4: Secure the social contract

The final objective is to ensure that productivity gains continue to translate into broad participation.

The Productivity Dividend, education, training, public services, and democratic institutions all become part of the mature system.

Timeline: approximately 15–25 years and beyond.

Transformation is therefore not a single event.

It is the point at which the new architecture becomes normal.

A Critical Safeguard

The roadmap must incorporate one important lesson from the simulations.

The Productivity Bond's variable coupon can create an unintended feedback loop if higher payments during productive periods increase borrowing and expand the debt stock.

That means the bond's design cannot focus solely on annual interest payments.

A future version may require a **principal-adjustment mechanism** - potentially reducing outstanding debt during severe downturns - or another rule that limits debt accumulation.

The purpose is to ensure that the bond's countercyclical design works at the level of the entire debt stock.

This should be tested extensively before large-scale implementation.

The lesson is important: a financial innovation should be scaled because it works, not because the theory says it should work.

The Milestones

The roadmap can be tracked through five broad milestones.

Milestone 1 - Year 2:
NPI defined, implemented, independently governed, and audited.

Milestone 2 - Year 3:
First Productivity Bond issued and evaluated.

Milestone 3 - Year 10:
Productivity Bonds established as a meaningful component of new issuance, with a functioning market.

Milestone 4 - Year 20:
Productivity Bonds represent approximately 20–30% of the debt portfolio, subject to market evidence.

Milestone 5 - Year 25+:
A mature Productivity Economy is operating, with productivity-linked financing and broad distribution mechanisms established.

These are guideposts, not deadlines.

A country that reaches a milestone earlier should not be forced to wait. A country that requires more time should not be forced to accelerate.

The Challenges

The transition faces genuine obstacles.

Political will

Governments must be willing to experiment with a new form of sovereign financing.

Institutional capacity

Statistical agencies, debt offices, regulators, and financial markets must have the expertise to support the instrument.

Investor acceptance

Investors must understand the risks and believe that the NPI is reliable.

Market liquidity

A new bond will initially have a smaller market than established sovereign securities. Liquidity will have to develop over time.

International coordination

Cross-border adoption will eventually require compatible standards and statistical frameworks.

Transition management

The government must manage conventional and Productivity Bonds together while avoiding excessive issuance of either.

None of these challenges is trivial.

But none requires rebuilding the entire financial system before taking the first step.

The Enablers

Several factors could accelerate the transition.

Political leadership can provide the mandate for experimentation.

Public engagement can build support for sharing productivity gains.

Institutional innovation can create the governance structures required for the NPI and the bond.

International cooperation can eventually establish common standards.

Technological progress, particularly AI and automation, can increase the productivity gains that make the model increasingly relevant.

The most important enabler, however, is evidence.

A successful pilot is more persuasive than a hundred policy speeches.

The Future

If the roadmap succeeds, the result is not simply a different government bond.

It is a different relationship between finance and the real economy.

The financial system would increasingly reward productive improvement rather than assuming that economic expansion must continue indefinitely.

The gains from that improvement could be shared through the Productivity Dividend.

Citizens would have greater economic security even as technology changes the nature of work.

Governments would have access to financing that is more closely connected to economic performance.

And the economy could pursue higher living standards without requiring perpetual increases in physical consumption.

That is the purpose of the roadmap.

It does not promise that the transition will be easy.

It does not guarantee that every element will work exactly as designed.

It offers something more useful:

a way to test whether a different financial architecture can work.

The first step is measurement.

The second is experimentation.

The third is evidence.

Only then should transformation begin.

The infinite debt problem is not an inevitable destination.

It is a design problem.

And design problems can be redesigned.

Chapter 12: CONCLUSION

This book began with a question:

How do we create a prosperous, stable civilisation without destroying the planet and without relying on infinite debt?

It is a question that has become more urgent with each passing year.

The question has two parts. First: how do we create a civilisation that is prosperous and stable over time? Second: how do we create that prosperity without destroying the planet or relying on perpetual debt-fuelled growth?

The two are connected. Much of the prosperity we have achieved has been built on debt, resource consumption, and the assumption that the economy can continue growing indefinitely. That assumption is becoming increasingly difficult to sustain.

The financial system demands growth. The planet has limits. Fixed claims on an uncertain future create vulnerability.

That is the central challenge this book has addressed.

One book cannot completely answer such a question. But it can identify the problem, propose an alternative, and provide a path forward. The rest is up to us.

The Problem in Brief

The problem in a nutshell is simple:

We built a financial system that assumes unlimited growth on a planet with limits.

The financial system is built around compound interest. Debt claims accumulate over time, while the economy and its resource base cannot expand indefinitely.

The planet is finite. Resources are finite. Ecological systems are finite. The growth that has supported the debt system cannot continue forever at the same rate.

We have attempted to manage this contradiction through monetary policy, financial repression, and increasing debt. But the underlying tension remains.

The problem is not that debt is inherently bad. Debt can finance productive investment and create enormous value.

The problem is the structure of debt: **fixed claims on an uncertain future.**

We have been borrowing against a future that may not arrive.

The Solution in Brief

The solution proposed in this book is to replace the mechanism of compound growth with a mechanism of **productive prosperity**.

The Productivity Economy rewards productivity rather than simply expansion. It shares the gains of productivity broadly and operates within the physical limits of the planet.

It rests on two central pillars:

The Productivity Bond is a sovereign debt instrument whose return is linked to productivity. Rather than requiring the government to make fixed economic claims regardless of conditions, it allows financing costs to move with the productive performance of the economy.

The Productivity Dividend distributes a portion of productivity gains to citizens. It ensures that the benefits of technological and economic progress are broadly shared and provides income that is not entirely dependent on employment.

Together, these mechanisms aim to create a financial system that is more stable, sustainable, and equitable.

The Productivity Economy is not about doing less. It is about **doing better**: improving efficiency, encouraging innovation, sharing gains, and aligning financial incentives with the economy we actually want.

The Evidence

The simulation results provide encouraging evidence, while also revealing important limitations.

The Productivity Bond can lower government financing costs by about **3%** in the model's realistic dynamic setting. On the scale of sovereign debt, even a small percentage difference can represent substantial savings.

However, the results also reveal an important problem. Variable coupons can create a feedback loop in which higher payments during good years increase borrowing, enlarge the debt stock, and raise future debt-service costs. Without an appropriate principal-adjustment mechanism, the bond can therefore increase fiscal distress despite its countercyclical design.

This does not invalidate the concept. It identifies a design problem that must be solved.

The hybrid bond, which combines productivity growth with revenue growth, performs better in the simulation: **11.8% lower cost, 25.9% lower distress probability, and 13.9% better welfare.**

The portfolio analysis indicates an optimal allocation of approximately **30% Productivity Bonds and 70% conventional debt**, reducing fiscal distress probability by **34%** while lowering expected costs.

The simulations also identify a critical variable: the government's ability to capture productivity gains. When the government captures more than 30% of AI-driven productivity gains, the bond substantially outperforms. Below 15%, its advantage becomes much smaller.

These results are not proof that the system will work exactly as modelled in the real world. They are evidence that the mechanism is worth testing - and that its weaknesses can be identified before large-scale implementation.

That distinction matters.

The purpose of the model is not to predict the future with certainty. It is to test whether a different financial architecture can plausibly work under realistic conditions.

The Implications

The implications extend beyond the bond itself.

For the financial system: the Productivity Bond introduces a form of state-contingent sovereign financing. It allows debt service to respond to economic performance and creates a closer connection between financial claims and productive capacity.

For the economy: the Productivity Economy rewards efficiency, innovation, and productive investment rather than treating aggregate expansion as the only measure of progress.

For society: the Productivity Dividend provides a mechanism for sharing productivity gains broadly. It can supplement employment income, reduce inequality, and help maintain demand as technology changes the labour market.

For the planet: an economy that can improve without requiring perpetual increases in physical consumption is better aligned with a finite resource base.

The objective is therefore not simply to avoid financial crisis. It is to build a system in which finance, economic incentives, society, and environmental limits are pulling in the same direction.

The Path Forward

The path forward is the roadmap outlined throughout this book.

Step 1: Statistical reform.
Define, implement, and independently audit the NPI.

Step 2: The pilot.
Design, issue, and monitor a small Productivity Bond to test the mechanism.

Step 3: The expansion.
Increase issuance, extend maturities, expand the investor base, and develop a secondary market.

Step 4: The integration.
Optimise the debt portfolio, refine the instrument, expand internationally, and begin building the new social contract around shared productivity gains.

Step 5: The transformation.
Scale the system where the evidence supports it, strengthen the institutional framework, and develop the broader architecture of the Productivity Economy.

This path is ambitious, but it does not require an overnight revolution. It allows conventional debt and Productivity Bonds to coexist while the new instrument proves itself.

It also requires political will, public engagement, institutional capacity, international cooperation, and continued technological progress.

Most importantly, it requires experimentation.

We should not replace one untested assumption with another. We should test the instrument, measure the results, identify the failures, improve the design, and scale only when the evidence supports doing so.

The Choice

The choice is ultimately ours.

We can continue with a system in which debt accumulates according to fixed claims, growth remains the primary measure of economic success, and the benefits of technological progress become increasingly concentrated.

Or we can begin building a system based on **productivity, sharing, and participation**.

The Productivity Economy does not promise a world without economic problems. It offers something more realistic: a financial architecture that can adapt to changing economic conditions rather than assuming the future will always resemble the past.

The choice is not between perfection and failure.

It is between continuing to rely on a system whose underlying assumptions are becoming increasingly difficult to sustain, or testing a different architecture while we still have time to improve it.

The Infinite Debt Problem

The infinite debt problem is the problem of making unlimited financial promises about a finite future.

It is debt that compounds regardless of whether the underlying economy can support those claims. It is a financial system that relies on perpetual growth to remain stable.

But the problem is not inevitable.

It is an invitation to redesign the system.

The Productivity Economy is one response to that invitation. The Productivity Bond provides a new form of sovereign financing. The Productivity Dividend provides a mechanism for sharing the gains. The NPI provides the measurement framework that connects them.

Together, they offer the possibility of a financial system better aligned with productivity, economic reality, and planetary limits.

The infinite debt problem is therefore not the end of the story.

It can be the beginning of a different one.

The Closing Image

Imagine a financial system in which debt is not simply a fixed claim on an uncertain future, but a partnership with the productive capacity of the economy.

Imagine an economy in which progress means becoming more efficient, capable, and prosperous - not simply consuming more.

Imagine a society in which the gains from productivity are broadly shared, so that technological progress becomes a source of collective prosperity rather than simply concentrated wealth.

Imagine the Productivity Bond becoming one part of a diversified sovereign debt system, and the Productivity Dividend becoming one mechanism through which citizens share in the gains of an increasingly productive economy.

That future is not guaranteed.

Nor is it necessary to believe that every element proposed in this book will work exactly as designed.

The important point is that the system can be redesigned.

We built the financial architecture we have today. We can improve it.

The infinite debt problem is not an inevitability.

It is an invitation - to redesign the financial system for a finite planet.

The choice is ours. The future is ours to build.

Chapter 13: The Ancient Problem of Debt

Think about it. If you've ever been in serious debt, you know the feeling: the sleepless nights, the knot in your stomach when the bill arrives, the way debt colours every decision and relationship.

The ancient world understood this intimately. People could be forced into slavery, families could be destroyed by unpayable obligations, and communities could be torn apart by the tension between creditors and debtors.

The suspicion of interest wasn't simply anti-business. It reflected a recognition that some things were more important than financial returns: social stability, community, and the ability of people to rebuild their lives.

The Archaeology of Debt

Much of what we know about ancient debt comes from the clay tablets of Mesopotamia. Thousands have been excavated, documenting loans, contracts, and legal disputes. Together, they provide a remarkably detailed picture of how debt functioned in the earliest civilisations.

A typical loan was straightforward. A farmer might borrow grain or silver from a temple or wealthy merchant. The amount, interest rate, repayment date, and collateral were recorded on a clay tablet. Both parties affixed their seals, and the tablet was stored as a legal record.

Interest rates were high by modern standards - typically around 20% for silver and 33% for grain. These rates reflected both risk and the seasonal nature of agricultural production. Grain borrowed before the harvest had to be repaid after it, so interest compensated the lender for the possibility of a failed harvest.

But these loans were more than financial transactions. The creditor was often a member of the same community - a neighbour, merchant, or relative. Debt was embedded in a social relationship.

The debtor was expected to repay, but the creditor was also expected to recognise circumstances beyond the debtor's control. A failed harvest could lead to an extension or forgiveness of the loan. The objective was not simply to enforce repayment at any cost, because destroying the debtor could also damage the community.

This was an important form of economic wisdom: a creditor's long-term interest depended on the continued health of the community.

The Jubilee

Perhaps the clearest expression of the ancient concern about accumulating debt was the **Jubilee**.

In ancient Israel, the Jubilee was described as a periodic reset involving the release of debts, the freeing of slaves, and the restoration of land. Its underlying principle was radical: debt should not be allowed to accumulate indefinitely until it destroys the social order.

You might reasonably ask: *Why would anyone lend if the debt could eventually be cancelled?*

Because the Jubilee was not simply charity. It was a structural response to the tendency of debt to accumulate and concentrate wealth and power.

Similar practices existed elsewhere. Mesopotamian rulers periodically issued decrees cancelling debts and restoring economic equilibrium. Ancient Egyptian rulers sometimes remitted debts and taxes. In Athens, Solon's **seisachtheia**, or "shaking off of burdens", addressed severe debt problems.

These practices were different in detail, but they responded to the same underlying problem: **debt can accumulate faster than the society supporting it can sustain.**

The ancient world understood something we sometimes forget:

Debt is a human institution, not a force of nature.

It can be created, modified, forgiven, regulated, or redesigned.

The Jubilee did not reject lending. It recognised its limits. Debt could finance productive activity, but it could not be allowed to become a permanent mechanism of social destruction.

The Moral Economy

The ancient suspicion of interest was rooted in what we might call a **moral economy** - the idea that economic relationships are embedded in social relationships.

The purpose of the economy was not simply accumulation. It was to sustain the community.

Stability mattered. Sufficiency mattered. Justice mattered.

This perspective can seem foreign to a modern economy that often treats economic relationships as technical transactions governed by prices and contracts. But the older view recognised something fundamental: **economic institutions reflect human values.**

The transition from the ancient moral economy to the modern financial system was not simply a progression from ignorance to knowledge. It was a transformation in values and institutions.

Debt gradually became less of a social relationship and more of a financial claim. Interest became a price rather than a moral concern. Periodic debt cancellation came to be viewed as interference with the market rather than a mechanism for maintaining stability.

That transformation was not inevitable. It resulted from centuries of changing institutions, ideas, technologies, and economic conditions.

And if financial institutions were created through human choices, they can be redesigned through human choices.

The Invention of Money

Understanding ancient debt also requires understanding the origins of money.

One influential interpretation is that early money was closely connected to credit and debt. Clay tablets recorded claims on future grain or silver, and transferable claims could function as a medium of exchange.

The important insight is that money is not merely an object. It is also a **social claim**.

A monetary claim represents an expectation that something of value can be received in the future. That makes trust fundamental. If people lose confidence that claims will be honoured, the monetary system itself becomes unstable.

Ancient societies understood the connection between credit, trust, and community. If claims accumulated beyond the community's capacity to honour them, the entire credit system could be threatened.

Debt forgiveness therefore had a function beyond helping individual debtors. It could reset the relationships on which future lending depended.

The Jubilee can be understood in this broader sense: not simply as forgiveness, but as a periodic restoration of economic and social capacity.

The Persistence of Suspicion

The suspicion of interest did not disappear with the development of modern economics.

It persisted in religious traditions, political movements, and financial crises. The Islamic prohibition of **riba**, for example, remains influential today and has contributed to the development of modern Islamic finance.

The concept of usury also returned repeatedly in response to exploitative lending. Debt became an important issue in anti-colonial movements, and the global financial crisis demonstrated again how excessive leverage could destabilise entire economies.

The persistence of this concern suggests that the ancient unease about debt was not simply primitive superstition.

Debt creates a relationship between creditor and debtor. It gives the creditor a claim on the debtor's future income and assets. When those claims become excessive, the relationship can become a source of economic and political power.

Ancient societies responded by developing mechanisms such as debt forgiveness, interest restrictions, and periodic resets.

The modern financial system has different institutions and vastly greater complexity, but the underlying problem remains recognisable:

Debt accumulates. Interest compounds. Claims grow. Eventually, the ability to honour those claims becomes the constraint.

The Lessons for Today

The ancient experience offers several lessons.

First, debt is a human institution.
It was created for particular purposes and under particular conditions. It can therefore be redesigned for new circumstances.

Second, debt has limits.
When financial claims grow beyond the productive capacity of the underlying economy, instability follows.

Third, periodic forgiveness can be a feature rather than a failure.
The Jubilee recognised that a functioning credit system sometimes requires a reset.

Fourth, the economy exists to serve society.
Economic institutions are means, not ends. When they cease to support human flourishing, they should be reconsidered.

Fifth, financial institutions are not neutral.
Their design determines who receives returns, who carries risk, and who has power.

Sixth, trust is fundamental to money and credit.
Financial systems ultimately depend on confidence that promises will be honoured. Excessive debt can undermine that confidence.

These lessons remain relevant even though today's financial system is vastly more sophisticated.

The question is still the same:

How do we manage debt so that finance serves the economy rather than the economy becoming trapped in the service of debt?

The Return of the Jubilee

There is a recurring modern movement to revive the idea of the Jubilee: debt forgiveness for developing countries, student debt relief, mortgage restructuring, and other forms of financial reset.

Such proposals are often dismissed as radical or irresponsible. But the underlying principle has deep historical roots.

The Jubilee does not necessarily mean abolishing debt. It recognises that debt has limits and that accumulated claims can eventually become destructive.

But debt forgiveness alone cannot solve the underlying problem.

It addresses the **stock of accumulated debt** without necessarily changing the mechanism that creates it.

If the financial system continues to reward the accumulation of fixed claims and depends on perpetual economic expansion to sustain them, the same problem can eventually return.

That is why the deeper solution requires institutional redesign.

We need financial instruments that can adapt to economic conditions rather than simply demanding fixed claims regardless of those conditions.

We need mechanisms that align the interests of lenders and borrowers with the long-term productive capacity of the economy.

This is where the **Productivity Bond** enters the story.

It does not eliminate debt. It changes the relationship between debt and economic performance. By linking returns to productivity rather than simply to the passage of time, it attempts to make sovereign financing more compatible with the economy's actual capacity to generate value.

The ancient world recognised that debt could not be allowed to grow without limits.

The modern world has developed extraordinary financial technology, but the underlying problem has not disappeared.

The question is no longer whether debt should exist.

The question is **what kind of debt should exist in the future.**

The ancient suspicion of interest was gradually replaced by the celebration of compound growth - a transformation that took centuries and was driven by intellectual, institutional, and technological change.

The next transformation may require us to ask a different question:

What if finance rewarded productive progress rather than assuming perpetual growth?

Chapter 14: THE BIRTH OF COMPOUND GROWTH

The Slow Transformation

The transition from suspicion of interest to the celebration of compound growth was not sudden. It took centuries and involved intellectual, institutional, and technological changes that reinforced one another.

New theories justified new financial institutions. Those institutions facilitated new technologies. New technologies generated wealth that made the new theories appear increasingly plausible. Together, they created a self-reinforcing system in which compound growth became a foundation of modern civilisation.

The transformation wasn't inevitable. It emerged from choices made by rulers, merchants, philosophers, religious thinkers, and eventually economists, shaped by wars, plagues, discoveries, and inventions. But once established, the system acquired momentum of its own.

The Intellectual Transformation

The intellectual transformation began during the Renaissance, as classical learning returned and new approaches to understanding the world developed.

Medieval Scholastic thinkers had struggled to reconcile the prohibition of interest with the practical requirements of commerce. Over time, they developed arguments allowing compensation for risk, opportunity cost, inflation, and other factors. The absolute prohibition gradually weakened.

The Reformation accelerated the process. John Calvin, for example, argued that biblical restrictions on interest applied particularly to lending to the poor rather than to commercial lending. Interest increasingly became acceptable as a normal feature of economic activity.

The Enlightenment pushed the transformation further. Economists such as Adam Smith, David Ricardo, and Jean-Baptiste Say developed theories of capital, interest, production, and markets that treated financial returns as part of an increasingly systematic economic framework.

The most important conceptual shift was the changing meaning of **capital**.

In the ancient and medieval world, capital was largely understood as accumulated wealth. In the modern economy, it increasingly came to be understood as a productive factor - an asset capable of generating future income.

Now, you might be thinking: *So we figured out that capital is productive. What's the big deal?*

The big deal is that once capital was understood as productive, interest could be understood differently. It was no longer necessarily a payment extracted from someone else's misfortune. It could be seen as a return on productive investment.

The usurer gradually became the investor. The sin became a productive return.

The Institutional Transformation

New financial institutions emerged to accumulate and deploy capital at increasing scale.

Banks developed across Europe, particularly in the Italian city-states, providing loans, accepting deposits, transferring money, and facilitating trade. Families such as the Medici helped establish banking networks that connected merchants, rulers, and markets across Europe.

Joint-stock companies were another crucial innovation. The Dutch East India Company, founded in 1602, allowed investors to pool capital and share risk. This model became an important foundation for the modern corporation.

Stock exchanges provided secondary markets where shares and bonds could be bought and sold, increasing liquidity and improving price discovery.

Insurance added another layer of financial infrastructure. Marine, fire, and eventually life insurance allowed investors and businesses to manage risks that might otherwise have discouraged investment.

These institutions did more than facilitate commerce. They changed the relationship between finance and society.

In earlier societies, economic relationships were deeply embedded in social relationships. As modern markets developed, economic activity increasingly became treated as a separate sphere governed by its own rules.

We still see the legacy of this shift today. We talk about "the economy" as though it were an external force rather than a system created and maintained by human institutions.

The Technological Transformation

Financial and intellectual changes were reinforced by technological ones.

The factory system brought workers and machines together, enabling greater division of labour, specialisation, and coordination. Production that had once taken place in homes and small workshops increasingly moved into large-scale industrial facilities.

The steam engine provided a new source of mechanical power. Coal could be converted into energy independently of human muscle, animal power, wind, or water.

Railways then transformed transportation. They reduced the cost and time of moving goods and people, expanded markets, and connected regions on an unprecedented scale.

These technologies reinforced one another. Steam power helped drive factories and railways. Railways transported the coal that powered steam engines. Factories produced goods for expanding markets.

Technology and finance therefore developed together, each increasing the potential of the other.

The Mathematical Breakthrough

The intellectual, institutional, and technological transformation was accompanied by a deeper mathematical understanding of compound interest.

Compound interest itself was ancient. What changed in the modern era was its formalisation and integration into an increasingly sophisticated financial system.

The mathematics is simple but powerful:

Future value = Principal × (1 + interest rate)^n

A loan or investment growing at 5% annually becomes **(1.05)^n** times its original value after *n* years.

The Rule of 72 provides a rough estimate of doubling time. Divide 72 by the interest rate: at 5%, an investment doubles in roughly 14.4 years; at 10%, about 7.2 years.

And here's the crucial point: the same mathematics that makes compound returns attractive to investors makes compound debt dangerous to borrowers.

If you're earning 5% on your savings, compounding is your friend. If you're paying 5% on a large debt, compounding works against you.

For a government carrying enormous debt, even modest interest rates can create substantial obligations over time.

Compound growth therefore became both a powerful engine of wealth accumulation and a mechanism through which financial claims could grow independently of the underlying economy.

The Moral Reversal

The deepest transformation was moral.

In the ancient and medieval world, usury was widely treated as a moral problem. Lending at interest could be seen as profiting from another person's need.

In the modern world, interest itself became increasingly normal. "Usury" came to mean excessive or exploitative interest rather than interest generally.

At the same time, capital changed from something associated primarily with accumulated wealth into something understood as productive.

This changed the moral status of financial returns. Interest could now be justified as compensation for providing productive capital.

The transformation extended beyond interest. The economy itself increasingly came to be treated as a technical system governed by its own mechanisms rather than as a moral institution subject to explicit social constraints.

That separation allowed economic activity to expand on an unprecedented scale. It also made it easier to overlook the social and environmental consequences of that expansion.

The Engine of Growth

By the 19th century, the basic elements of the new system were established.

Interest was no longer inherently suspect. Capital was understood as productive. Compound growth had become an important mechanism for accumulating wealth.

The resulting cycle was powerful:

Capital → investment → technology → productivity → profits → reinvestment → more capital.

Fossil fuels amplified the cycle. Coal, oil, and natural gas provided enormous quantities of concentrated energy, allowing machines to replace human and animal labour and expanding the scale of production.

Population growth provided another tailwind. More people meant more workers, consumers, and potential innovators.

Resource extraction provided another. New land, minerals, and energy sources supplied the inputs required by industrial expansion.

Together, these forces produced an extraordinary period of economic growth.

Between 1820 and 2000, global GDP increased many times over. Living standards rose dramatically across much of the world. Life expectancy increased, literacy expanded, and the material conditions of human life were transformed.

The achievement was real. But so were the conditions that made it possible.

The Inevitability Question

Was this transformation inevitable?

No.

It was the result of particular choices and circumstances. Different religious interpretations, political decisions, technological developments, wars, discoveries, and institutions could have produced a different path.

The transformation was also dependent on abundant fossil fuels and resources. Coal powered the Industrial Revolution; oil powered much of the expansion that followed. Population growth provided a major demographic tailwind.

Remove enough of these conditions and the trajectory changes.

The system of compound growth was therefore not a law of nature. It was a historical outcome produced by a particular combination of institutions, technologies, resources, and demographics.

And that matters because what people created can be redesigned.

The Legacy of the Transformation

We have inherited this system.

Compound growth is embedded in financial markets, government borrowing, pensions, investment expectations, corporate structures, and economic policy. It shapes how we think about the future and what we expect from it.

Its legacy is mixed.

On one side, the system generated extraordinary prosperity. It lifted billions of people from extreme poverty, expanded opportunity, and enabled technological and scientific achievements that would have been unimaginable to earlier generations.

On the other, it contributed to enormous concentrations of wealth and power, environmental destruction, and an economic structure increasingly dependent on continued expansion.

More importantly, many of the conditions that supported the great expansion are changing.

Population growth is slowing. Resources are becoming more constrained. Environmental costs are rising. The era of exceptionally cheap fossil energy cannot simply be assumed to continue indefinitely.

We cannot simply abandon the financial system that developed during the great expansion. It is too deeply embedded in modern society.

But we can redesign parts of it.

The **Productivity Bond** is one such redesign. It doesn't eliminate debt or interest. Instead, it changes the relationship between financial returns and economic performance by linking the return to productivity rather than requiring perpetual expansion.

The Path Forward

The transformation from the ancient suspicion of interest to the modern celebration of compound growth took centuries. The transformation we now need will not happen overnight either.

Moving from a system dependent on perpetual growth toward one that rewards productivity will require changes in ideas, institutions, and technology.

But the principle is straightforward.

Debt is a human institution. Financial contracts are human inventions. The way we structure returns is a choice.

We don't need to return to the ancient suspicion of interest. We need to recover the insight behind it: **financial claims have limits, debt creates relationships, and the financial system ultimately exists to serve the economy and society.**

The Productivity Bond is one practical, testable step in that direction.

The transformation from suspicion to celebration created the physical and institutional conditions for the great expansion of the last two centuries - an era built on five pillars: **land, population, fossil fuels, industrialisation, and global trade.**

Chapter 15: THE GREAT EXPANSION

The Five Pillars

The great expansion of the last two centuries was built on five pillars: **land, population, fossil fuels, industrialisation, and global trade.** Together, they created the conditions under which perpetual economic expansion seemed not only possible but inevitable.

The first was **land**. The discovery and colonisation of the Americas, Africa, Australia, and New Zealand opened vast territories for cultivation, extraction, and settlement. These lands were not empty; indigenous peoples were displaced, enslaved, or killed. But from the perspective of the expanding European economy, they represented a new frontier of resources and opportunity.

The second was **population**. Between 1800 and 2000, the global population grew from roughly 1 billion to 6 billion. More people meant more workers, consumers, and innovators. The demographic transition created a powerful tailwind for economic expansion.

The third was **fossil fuels**. Coal, oil, and natural gas provided energy on a scale previously unimaginable. A barrel of oil contains energy equivalent to thousands of hours of human labour. Fossil fuels effectively multiplied the productive power available to civilisation.

The fourth was **industrialisation**. Factories, machinery, division of labour, and the application of science to production produced enormous gains in productivity. Goods that had once been expensive and labour-intensive could be produced at unprecedented scale.

The fifth was **global trade**. Railways, steamships, telegraphs, container ships, and eventually the internet reduced the cost of moving goods and information. Regions could specialise, trade with one another, and participate in increasingly integrated global markets.

These pillars reinforced one another. Land supplied resources. Population supplied labour and demand. Fossil fuels supplied energy. Industrialisation supplied technology. Trade connected everything into a global market.

Together, they created a self-reinforcing cycle of expansion.

The Frontier

The frontier was more than a geographical boundary. It was an economic assumption: **there was always more.**

For two centuries, when resources became scarce there was often another territory to explore, another mineral deposit to discover, another market to open, or another source of energy to exploit.

The American West embodied this mentality, as did European colonial expansion across Africa, Asia, Australia, and elsewhere. The colonial project was deeply rooted in exploitation, racism, and imperialism, but it also supplied raw materials, markets, land, and investment opportunities that fuelled economic expansion.

The frontier hid limits.

When land became crowded, there was somewhere else to go. When resources became scarce, there was somewhere else to search. When markets became saturated, new ones could be opened.

That era is largely over.

There are still frontiers in science, technology, space, and the oceans. But they cannot provide the same economic release valve. We cannot simply move to another continent when resources are depleted or climate conditions deteriorate.

The challenge has changed from **finding more** to **using what we have more effectively**.

The Demographic Dividend

Population growth provided another powerful tailwind.

For most of human history, high birth and death rates kept population growth relatively slow. The demographic transition changed this. Death rates fell through improvements in sanitation, public health, and medicine, while birth rates declined later.

The result was a period in which the working-age population grew faster than dependants - the **demographic dividend**.

More workers increased production. More consumers increased demand. More people also meant more potential innovators and entrepreneurs.

But the same transition eventually produces the opposite effect.

Birth rates are now falling across much of the developed world and increasingly across developing economies. Populations are ageing, and the ratio of workers to retirees is declining.

The demographic tailwind is becoming a headwind.

For two centuries, economic expansion benefited from becoming more numerous. The future will increasingly require becoming **more productive**.

The Fossil Fuel Revolution

The fossil fuel revolution was perhaps the most powerful of the five pillars.

Before industrialisation, economic activity depended largely on human and animal labour, along with energy from wind, water, and biomass. These sources imposed strict limits on the scale of production.

Coal, oil, and natural gas broke through those limits.

Fossil fuels provided concentrated energy that could power machines, factories, transport, agriculture, and eventually almost every part of the modern economy. The Industrial Revolution was therefore not simply a technological revolution; it was an energy revolution.

But fossil fuels are finite, and their environmental costs are enormous.

Their combustion releases carbon dioxide, driving climate change and contributing to a range of environmental pressures. The same energy abundance that enabled unprecedented productivity also created an ecological burden that cannot continue indefinitely.

The lesson is not that energy must disappear. It is that future prosperity must increasingly come from **using energy more efficiently and generating it more sustainably**.

The Industrial Revolution

Industrialisation transformed productivity.

The factory system concentrated workers and machines, allowing production to be organised around specialisation, division of labour, and scale.

The steam engine converted fossil fuels into mechanical power. Science and engineering then accelerated the development of new materials, processes, machines, and products.

The result was a dramatic increase in productive capacity.

But industrialisation also created new forms of exploitation, inequality, pollution, and environmental damage. Its legacy is therefore mixed: it dramatically improved material living standards while also creating costs that were often ignored or externalised.

The challenge now is not to abandon industrial productivity but to **retain its benefits while reducing its environmental and social costs**.

The Global Trade Revolution

Global trade completed the expansionary system.

Railways, steamships, telegraphs, containerisation, and digital communications dramatically reduced the cost of moving goods and information.

This allowed regions to specialise and trade. Knowledge and technology spread more quickly. Production became increasingly global.

The gains were enormous, but so were the vulnerabilities.

An interconnected economy can transmit shocks quickly. A financial crisis, pandemic, war, or supply disruption in one region can affect economies everywhere.

Global trade is also facing political and geopolitical pressures. Protectionism, nationalism, strategic competition, and supply-chain concerns are challenging the assumption of ever-deeper integration.

The global system remains powerful, but it is also more fragile than its efficiency alone might suggest.

The Cycle of Growth

The five pillars formed a reinforcing cycle:

Resources → energy → industrialisation → productivity → wealth → investment → trade → further expansion.

Population growth supplied workers and consumers. Global trade expanded markets. New technologies increased productivity. Fossil fuels powered the system. The frontier supplied additional resources and opportunities.

Growth generated more capacity for growth.

But the conditions that sustained this cycle are changing.

The frontier has largely closed. Population growth is slowing. Fossil fuels carry increasing environmental costs. Resources are more constrained. Global trade faces geopolitical friction.

The cycle is not necessarily ending, but the assumptions that powered it are weakening.

The Limits of Growth

The great expansion was an extraordinary achievement. It lifted billions of people out of poverty and transformed the material conditions of human life.

But it was never unlimited.

Land is finite. Resources are finite. Ecosystems have limits. The biosphere has a limited capacity to absorb waste.

For much of the expansion, these constraints were difficult to see. New resources could be discovered, new land opened, and environmental costs pushed into the future.

That is changing.

Climate change is the most visible constraint, but it is not the only one. Biodiversity loss, freshwater depletion, ocean degradation, and land degradation all indicate increasing pressure on planetary systems.

The constraints are also economic. Resource costs can rise. Demographic growth can slow. Productivity gains can weaken.

And they are social. Persistent inequality can undermine trust and the stability of the social contract.

The great expansion was therefore not a permanent condition. It was the product of a particular combination of circumstances that cannot simply be reproduced.

The Implications for the Financial System

The great expansion shaped modern finance.

Bonds, mortgages, pensions, corporate investment, and other financial arrangements developed within an environment in which tomorrow was generally expected to be larger than today.

The financial system also helped create that growth. It channelled savings into investment, distributed risk, provided liquidity, and allowed capital to be deployed at enormous scale.

Finance was therefore both beneficiary and driver of the expansion.

But the relationship becomes more difficult when growth slows.

A financial system built around assumptions of continual expansion must adapt when those assumptions become less reliable. It needs ways to generate sustainable returns, manage risk, and finance investment without requiring the economy to become permanently larger.

That is the problem addressed by the **Productivity Bond**.

Rather than tying financial returns to perpetual economic expansion, it links them to productivity - to how effectively the economy uses its resources.

The great expansion taught us how powerful growth can be when land, population, energy, technology, and trade all reinforce one another.

The next challenge is different.

We must learn how to create prosperity when those conditions no longer guarantee that tomorrow will be larger than today.

Chapter 16: WHEN GROWTH BECAME THE ANSWER

The Post-War Consensus

The Second World War marked a turning point in economic policy. Governments had demonstrated that they could mobilise enormous resources, coordinate complex production, and manage economies on an unprecedented scale.

After the war, those capabilities were redirected toward reconstruction and growth.

The emerging consensus was simple: **growth was the answer**.

Growth would create jobs, raise living standards, fund social programs, stabilise economies, and help prevent a return to the Great Depression. It would also provide the prosperity needed to rebuild societies after the devastation of war.

The institutions created at Bretton Woods in 1944 reflected this vision. The International Monetary Fund, World Bank, and General Agreement on Tariffs and Trade were designed to support international economic stability, trade, investment, and development.

The consensus extended beyond policy. People came to expect that the future would be better than the present and that their children would be richer than they were.

For roughly three decades, that expectation appeared justified. From 1945 to the 1970s, much of the industrialised world experienced extraordinary economic growth and rising living standards.

But the post-war system was built in a particular historical environment - one of abundant resources, expanding populations, reconstruction, and rapid productivity growth.

That environment would not last forever.

The Policy Shift of 1971

A major financial turning point came on **15 August 1971**, when President Richard Nixon suspended the convertibility of the US dollar into gold.

The Bretton Woods monetary system effectively came to an end.

This did not mean that money suddenly became "backed by nothing." Modern fiat money is supported by government institutions, taxation capacity, legal frameworks, monetary policy, and confidence in the currency. But the direct convertibility of the dollar into gold was removed.

The change mattered because the monetary system was no longer constrained by a fixed gold-convertibility regime.

Credit and money creation could expand more flexibly in response to economic conditions.

This did not automatically create debt-driven growth, nor did the end of gold convertibility remove all constraints on borrowing. Inflation, interest rates, taxation, fiscal capacity, productive capacity, and confidence remained important constraints.

But the financial system entered a new era in which credit could expand on a much larger scale.

Debt increasingly became a claim not on a fixed quantity of a physical commodity, but on future monetary income.

That distinction would become increasingly important as debt accumulated.

The Great Moderation

From roughly the mid-1980s to 2007, advanced economies experienced what became known as the **Great Moderation**: relatively stable growth, declining inflation volatility, and fewer severe economic fluctuations.

Several factors contributed, including improved monetary policy, inflation targeting, structural changes in advanced economies, and greater international integration.

The stability also changed expectations.

People increasingly assumed that economic conditions would remain predictable. Businesses invested, households borrowed, and financial institutions took greater risks within an environment that appeared increasingly manageable.

At the same time, financialisation accelerated.

Financial institutions expanded rapidly. New products such as derivatives, securitisation, and structured finance allowed financial claims to be created, packaged, traded, and leveraged on an enormous scale.

Finance provided real benefits: liquidity, diversification, risk management, and more efficient allocation of capital.

But complexity also created vulnerabilities.

The financial system became increasingly interconnected, and risks that appeared manageable in isolation could become systemic when markets moved together.

The apparent stability of the Great Moderation encouraged behaviour that ultimately made the system more fragile.

The Normalisation of Debt

Debt gradually shifted from being a last resort to being a normal mechanism for financing both investment and consumption.

Governments borrowed for infrastructure and public programs. Businesses borrowed to invest and expand. Households borrowed for homes, education, vehicles, and consumption.

Several forces encouraged this shift: increasingly sophisticated financial products, periods of declining interest rates, rising asset prices, and easier access to credit.

But the deepest support was the belief in future growth.

If tomorrow was expected to be richer than today, borrowing against tomorrow seemed reasonable.

Debt therefore became embedded in everyday economic life.

That brought benefits. Credit allowed households to buy homes, businesses to invest before they had accumulated sufficient savings, and governments to finance projects whose benefits would arrive over many years.

But debt also creates fixed obligations.

When incomes and asset values rise, those obligations may appear manageable. When growth slows, they become more burdensome.

The result is a fundamental dependency:

Debt requires income to service it, and income is increasingly dependent on economic performance.

The Dependence on Growth

By the end of the 20th century, growth had become more than an economic objective. It had become embedded in the structure of modern society.

Governments relied on expanding tax bases to fund public services. Businesses relied on growing revenues and profits. Households relied on rising incomes and asset values. Pension systems relied on investment returns.

Financial institutions also depended on borrowers being able to service their obligations.

Growth therefore became both an expectation and a structural support.

If growth slowed significantly, governments could face greater fiscal pressure, businesses could struggle to service debt, pension assets could underperform, and households could face declining incomes or asset values.

The problem wasn't that every institution literally required perpetual GDP growth. It was that a large number of institutions had been designed around an expectation of continued economic expansion.

The financial system was built for a world in which tomorrow was generally expected to be larger than today.

Financialisation

Financialisation deepened this dependence.

Finance developed increasingly sophisticated ways to create and trade financial claims. Derivatives, securitisation, structured products, and leverage expanded the scale of the financial system far beyond traditional banking.

This created genuine efficiencies, but it also changed incentives.

More economic activity became connected to financial markets. Household wealth became increasingly tied to property and financial assets. Corporate decisions were increasingly influenced by financial returns and market valuations.

The financial sector became both a facilitator of productive activity and, at times, a source of instability.

The more interconnected the system became, the more difficult it was to understand where risk ultimately sat.

The lesson isn't that finance is inherently harmful. Finance is essential to a modern economy.

The problem is what happens when financial claims grow faster than the productive capacity supporting them.

The Psychological Shift

The dependence on growth was also psychological.

The post-war experience created a powerful expectation of progress. People had experienced rising incomes, expanding consumer choice, improving technology, and longer lives.

Growth became synonymous with progress.

Governments promised it. Businesses planned around it. Investors expected it. Economists measured it. Society came to regard it as the normal direction of history.

This created a difficult feedback loop.

If people expect continued growth, they are more willing to borrow, invest, spend, and take risks. Those actions can support growth, reinforcing the original expectation.

But the reverse is also true.

If growth persistently disappoints expectations, debt becomes harder to service, investment returns weaken, and confidence falls.

A financial system built around expectations of expansion becomes vulnerable when those expectations change.

The Debt-Growth Cycle

The resulting cycle can be expressed simply:

Growth → borrowing → debt → need for future growth → more borrowing.

Governments borrow to support investment and demand. Businesses borrow to expand. Households borrow against expected future income.

The financial system supplies the credit that supports the process, while the political system has incentives to maintain economic expansion.

When growth is strong, the cycle appears sustainable. Rising incomes make debts easier to service.

When growth weakens, the same debt becomes a constraint.

This is why the problem is deeper than simply "too much debt." The issue is the relationship between **fixed financial claims and uncertain economic performance**.

The Unasked Question

For much of the great expansion, one question remained largely in the background:

What happens if growth stops?

The question was difficult to ask because growth had become so deeply associated with prosperity and stability.

But the answer does not have to be collapse.

A mature economy can adapt to slower growth. Productivity can continue to improve even when population growth slows. Living standards can rise through better use of resources rather than simply through greater consumption.

The financial system can also be redesigned.

Instead of assuming that every financial claim must grow at a predetermined rate regardless of economic performance, some instruments could allow returns to move with the productive capacity of the economy itself.

That is the principle behind the **Productivity Bond**.

It is not a claim that growth should disappear. It is a proposal for separating **prosperity from perpetual expansion**.

The system we inherited isn't necessarily broken. It is **incomplete** - designed for a world of expanding populations, abundant energy, plentiful resources, and consistently rising output.

The question now is whether we can redesign it for the world that comes next.

Chapter 17: The Arithmetic of Tomorrow

The Unforgiving Mathematics

The mathematics of compound interest is unforgiving. It is one of the simplest and most powerful forces in finance - and one of its most dangerous.

If you lend $100 at 5% interest and the interest compounds, you have $163 after 10 years, $265 after 20, $432 after 30, $1,147 after 50, and $13,150 after 100.

The expansion is exponential, not linear. The longer the time horizon, the more dramatic the outcome. The Rule of 72 gives a useful shortcut: at 5%, money doubles roughly every 14.4 years; at 10%, every 7.2 years; at 20%, every 3.6 years.

The same arithmetic applies to government debt.

Consider a government with $100 billion in debt at 4% interest. If it does nothing to reduce the principal, the debt grows to approximately $149 billion in 10 years, $222 billion in 20, $324 billion in 30, $480 billion in 40, and $711 billion in 50.

The government does not need to issue new debt for this to happen. Existing debt compounds by itself.

That creates a fundamental requirement: for debt to remain manageable, the economy must grow at least as fast as the debt burden. If the economy grows at 3% while debt grows at 4%, the debt-to-GDP ratio tends to rise. If the economy grows at 3% while debt grows at 2%, it tends to fall.

One percentage point can make an enormous difference over decades.

The problem is that economic growth cannot be guaranteed. It depends on productivity, demographics, technology, resources, investment and ecological stability. If growth slows, debt becomes harder to carry. If growth stops, the assumptions underlying a growth-dependent financial system are tested.

The r > g Dynamic

The French economist Thomas Piketty popularised the relationship between the rate of return on capital, **r**, and the rate of economic growth, **g**.

In his framework, when **r > g**, wealth held in capital can grow faster than the economy as a whole. Over time, this can increase the concentration of wealth.

The relationship is not a universal law. It is a historical and economic observation, and its effects depend on taxation, saving, inheritance, asset prices, productivity and other factors.

But the underlying arithmetic matters for debt as well.

When the effective interest rate on government debt exceeds the growth rate of the economy, debt can grow faster than national income. The debt-to-GDP ratio then becomes harder to stabilise.

That is the deeper problem: financial claims can compound independently of the physical economy that ultimately supports them.

When returns consistently outrun the economy's capacity to generate income, wealth can accumulate faster than the productive base beneath it. The resulting imbalance is not necessarily a crisis today. It is a problem that compounds over time.

The Debt-to-GDP Ratio

The debt-to-GDP ratio is one of the simplest measures of debt sustainability. Its movement depends mainly on three variables:

1. **The primary deficit:** government spending minus revenue, excluding interest payments.
2. **The interest rate:** the effective rate paid on government debt.
3. **The growth rate:** the rate at which nominal GDP grows.

A simplified version of the debt dynamics is:

$$\Delta(D/Y) = (D/Y)(r - g) + deficit/Y$$

Where:

- **Δ(D/Y)** = change in the debt-to-GDP ratio
- **D/Y** = existing debt-to-GDP ratio
- **r** = effective interest rate
- **g** = nominal GDP growth rate
- **deficit** = primary government deficit

In plain English, the debt ratio tends to rise when interest costs exceed economic growth or when the government runs a primary deficit. It tends to fall when growth exceeds interest costs or when the government runs a primary surplus.

The formula becomes especially important at high debt levels because the existing debt itself magnifies the effect of the **r – g** difference.

If **r > g**, even a balanced primary budget may not be enough to stabilise the ratio.

That is the arithmetic governments eventually have to confront.

The Tipping Point

Debt does not have one universal tipping point.

A debt-to-GDP ratio that is manageable for one country may be dangerous for another. The outcome depends on interest rates, growth, currency arrangements, maturity structures, fiscal credibility, institutional strength and investor confidence.

The important variable is not simply the size of the debt. It is the relationship between the debt and the economy's capacity to service it.

At high debt levels, a worsening **r – g** relationship can become self-reinforcing. Rising debt may increase perceived risk. Higher perceived risk can raise borrowing costs. Higher borrowing costs increase debt-service costs, which can push debt higher still.

The reverse can also occur. Stronger growth and lower borrowing costs can improve debt dynamics, reducing pressure on government finances.

This is why debt sustainability is better understood as a dynamic process than as a single threshold.

Japan illustrates the point. It has sustained a very high debt-to-GDP ratio for decades, supported by unusually low interest rates, a large domestic investor base and other institutional factors. That does not mean any country could safely sustain the same ratio under different conditions.

The lesson is simple: **there is no magic debt number. The arithmetic depends on the system around it.**

The Government's Options

When debt becomes difficult to sustain, governments have several options:

1. **Run primary surpluses.** Spend less than revenue. This directly reduces debt, but usually requires spending cuts, higher taxes or both.
2. **Extend maturities.** Borrow for longer periods to reduce refinancing risk.
3. **Keep interest rates low.** This can reduce debt-service costs, although it can create other economic distortions.
4. **Sell assets.** State-owned assets can be sold to reduce debt, although this is usually a one-off solution.
5. **Raise taxes.** Higher revenue can reduce deficits, but tax increases are politically difficult.
6. **Increase productivity and growth.** A stronger productive economy increases the income available to service debt, although growth cannot simply be commanded.

7. **Allow inflation.** Inflation can reduce the real burden of existing nominal debt, but it also reduces purchasing power and can damage confidence.

8. **Default or restructure.** This can reduce the immediate debt burden but carries potentially severe economic and financial consequences.

Every option has costs.

That is why governments tend to prefer borrowing. The benefits of spending are immediate and visible; the costs of accumulated debt arrive later and are distributed across the future.

Compound interest does not care which government made the promise.

The Arithmetic of Promises

Debt is only part of the problem. Governments also make promises about future spending.

Some are **explicit**: bonds, loans and other contractual obligations.

Others are **implicit or contingent**: pensions, healthcare, social security and other programmes whose future costs depend on legislation, demographics and economic conditions.

These obligations can become difficult when the population ages, healthcare costs rise or the tax base grows slowly.

The underlying issue is the same: future claims must ultimately be supported by future income and production.

If promised payments grow faster than the productive economy, something eventually has to change - taxes, benefits, retirement ages, eligibility, borrowing, inflation or the promises themselves.

The arithmetic does not tell us which political choice will be made. It tells us that choices cannot be avoided forever.

The Limits of the Arithmetic

Compound growth cannot continue indefinitely in a finite physical system.

Financial claims can be represented mathematically as exponential functions. The real economy cannot expand without limits because it operates within constraints imposed by resources, energy, demographics, infrastructure and ecological systems.

That does not mean economic progress must stop.

It means that **growth in physical throughput** and **growth in economic value** are not the same thing.

An economy can become more productive without consuming proportionally more resources. Better software, more efficient energy systems, improved logistics, automation, scientific knowledge and better use of existing infrastructure can all increase output from a given resource base.

This distinction is central to the argument of this book.

The problem is not growth itself. The problem is building a financial system that requires perpetual expansion of the underlying physical economy to remain stable.

Think about it this way: if your debt grows at 4% while your income grows at 2%, the gap compounds against you. You either increase your income, reduce your debt, lower the cost of the debt, or change the terms.

The same principle applies at the national level.

The Productivity Alternative

This points toward a different arithmetic: **productivity**.

Growth asks how much larger the economy becomes.

Productivity asks how much more effectively the economy uses what it already has.

That distinction becomes increasingly important in a world where resources are constrained and automation can dramatically increase the amount of output produced by each unit of labour, capital, energy or material.

A productivity-based economy does not require every improvement to come from consuming more resources. It can create value through efficiency, innovation, automation, knowledge and better allocation.

This is the foundation of the Productivity Economy proposed in this book.

The Productivity Bond is designed around the same principle. Rather than tying financial returns solely to the expansion of the economy, it links them to measurable improvements in productivity.

If the economy becomes more efficient, investors participate in the gains. If productivity weakens, returns adjust accordingly.

The result is a different relationship between finance and the real economy: financial claims are connected not simply to **how much bigger the economy becomes**, but to **how much better it becomes at using what it has**.

That is the arithmetic of tomorrow.

The arithmetic of compound interest is unforgiving because financial claims can compound indefinitely on paper.

The physical economy cannot.

The challenge is therefore not to defeat mathematics, but to design a financial system whose mathematics is compatible with the world in which it operates.

Chapter 18: The Worker Who Wasn't There

The End of Work?

For most of human history, work was the foundation of economic life. People worked to produce food, shelter and clothing, support their families and build their communities. Work was not merely a source of income; it was also a source of identity, purpose and meaning.

The Industrial Revolution changed the nature of work without eliminating it. Labour moved from farms to factories, from agriculture to manufacturing and from rural communities to cities. The work changed. The workers remained.

The AI revolution may be different.

For the first time, technology can perform not only physical tasks but increasingly cognitive ones. Production could continue to rise while the need for human labour falls.

The worker who wasn't there is the worker whose task is performed by a machine.

That raises a fundamental economic question: what happens when production no longer requires the same number of people to produce it?

The traditional economic cycle - wages to consumption, consumption to production, production to wages - depends heavily on employment. If employment becomes less central to production, that cycle has to change.

You might reasonably object: *We've heard this before. The Luddites thought machines would destroy jobs, and they were wrong.*

They were. Previous technological revolutions displaced workers but also created new forms of employment.

The question is whether AI can repeat that pattern at sufficient scale.

The Automation of Cognitive Labour

Previous technological revolutions primarily automated physical labour. The steam engine replaced muscle. Industrial machinery replaced repetitive manual tasks. Computers automated calculation and information processing.

AI moves further into cognitive work.

It can analyse documents, generate software, interpret images, conduct research, answer questions, produce content, optimise operations and assist with decision-making.

That matters because cognitive work represents a large share of modern economic activity.

The transition is already visible. Law firms use AI for document review and research. Hospitals use AI-assisted systems to analyse medical images. Businesses use AI for customer service, logistics, forecasting and administration. Creative industries use it to generate text, images, audio and video.

The important distinction is not that AI will replace every worker. It is that **one system can increasingly perform tasks that previously required many workers**.

A law firm that once needed hundreds of junior employees to review documents may eventually need far fewer. A customer-service operation may handle a much larger volume of enquiries with fewer people. A company may produce more software with a smaller development team.

The work still exists.

The worker may not.

The Productivity-Employment Tradeoff

Automation creates an apparent tradeoff between productivity and employment.

Machines can work continuously, replicate instantly and perform some tasks at very low marginal cost. This can dramatically increase output per worker.

But when a machine performs a task previously performed by a person, fewer workers may be required.

Historically, displaced workers often moved into new industries. Agricultural automation reduced farm employment while industrialisation created factory jobs. Later, automation reduced some manufacturing employment while services expanded.

The uncertainty with AI is whether the creation of new human jobs will keep pace with the destruction or transformation of existing ones.

AI may create new occupations, industries and forms of work. But those jobs may require different skills, and the transition may be faster than workers and institutions can adapt.

That creates a new problem for the financial system.

The system relies heavily on employment to distribute purchasing power. Workers receive wages. They spend those wages. Businesses receive revenue and invest. Investment creates further production and employment.

If production rises while employment falls, that feedback loop becomes weaker.

Imagine a factory that becomes ten times more productive while employing one-tenth as many people. Production can increase dramatically, but the workers who have disappeared from the payroll no longer receive the wages that once supported demand.

The problem is not a lack of productive capacity.

It is the distribution of purchasing power.

The Breaking of the Link

For much of the industrial era, economic growth and employment were closely connected.

More production generally required more workers. More workers earned more income. More income supported more consumption. Rising demand encouraged more production.

AI can weaken that relationship.

Production can increase without proportional increases in employment. Productivity can rise while the number of workers required to produce a given quantity of output falls.

That does not mean economic growth will necessarily eliminate jobs. It means **growth can no longer be assumed to create employment at the same rate as before**.

This distinction matters enormously.

If the financial system assumes that economic expansion automatically produces broad-based wage income, but technological progress increasingly separates production from employment, some of those assumptions become outdated.

The challenge is therefore not to stop technological progress.

It is to build an economic system capable of distributing purchasing power even when productive capacity becomes less dependent on human labour.

The Circular Flow Problem

The traditional circular flow is straightforward:

Workers earn wages → wages fund consumption → consumption creates demand → demand supports production → production supports employment.

AI can weaken the employment link within that cycle.

If fewer workers are required, wage income can become a smaller share of total economic income. Without another mechanism for distributing purchasing power, consumption can become increasingly concentrated among those who own the productive assets.

This creates a potential mismatch:

productive capacity rises while purchasing power becomes concentrated.

The problem is therefore not that society becomes unable to produce enough.

It may become exceptionally good at producing enough.

The problem is who receives the income generated by that production.

That makes distribution a central economic question of the AI era.

The Productivity Dividend is designed as one possible response. By distributing part of the gains from rising productivity to citizens, it creates a source of purchasing power that is not entirely dependent on employment.

The objective is to keep the circular flow functioning even as the role of labour changes.

The Distributional Crisis

Automation can create a distributional problem because its benefits may initially accrue disproportionately to the owners of productive capital.

The companies developing and deploying AI capture revenue and profits. Their shareholders and other capital providers participate in those gains.

Workers displaced by automation experience the opposite effect: their bargaining power can weaken, their income can fall and their employment may become less secure.

This does not mean every AI gain will automatically flow to capital or that workers will necessarily lose overall. Institutions, competition, taxation, new industries and labour shortages can all change the outcome.

But the possibility of widening inequality is real enough to require a policy response.

The issue is particularly important because broad-based consumption remains essential to a market economy.

If productivity gains are concentrated among people who already possess substantial wealth, the economy can become increasingly productive without distributing purchasing power broadly enough to sustain demand.

The result could be an economy with extraordinary productive capacity and insufficiently distributed income.

That is the distributional challenge.

The New Social Contract

The industrial social contract was built largely around employment.

People worked. They earned wages. They paid taxes. They consumed. They accumulated savings. They received pensions and other benefits.

If employment becomes less central to economic production, that contract must evolve.

A new social contract could be based on a broader principle:

Everyone should have a stake in the productivity of the economy, whether or not everyone is required to work in the traditional sense.

That does not mean eliminating work.

People will continue to work because work provides income, purpose, status, creativity and social connection. Many forms of work may also remain difficult to automate.

But employment may become less necessary as the sole mechanism for distributing economic prosperity.

The Productivity Dividend is one proposed mechanism. It would distribute a portion of productivity-linked revenues to citizens, creating a direct connection between technological progress and public prosperity.

The Productivity Bond complements this by linking part of the financial system to productivity rather than relying entirely on conventional growth.

Together, they represent the beginning of a different social contract: one in which productivity gains can be shared without requiring every person to remain economically indispensable to the production process.

The Role of the Productivity Bond

The Productivity Bond is designed for precisely this transition.

Its purpose is not to stop automation. Automation is one of the main sources of the productivity gains the model is intended to capture.

Instead, the bond creates a financial claim linked to those gains.

As productivity increases, the return can increase within the model's defined limits. When productivity weakens, the return adjusts.

This creates a different relationship between technological progress and finance.

Under a conventional system, the owners of productive capital may capture most of the gains from automation.

Under the proposed system, productivity-linked financial instruments can provide another channel through which those gains are shared.

The Productivity Dividend extends that principle to citizens.

The result is not a promise that everyone will receive an equal share of every technological gain. It is a mechanism for ensuring that rising productivity can generate a broader economic benefit.

The bond is therefore not a solution to automation itself.

It is a mechanism for adapting finance to automation.

Beyond Employment

The deeper question is whether employment should remain the primary gateway to economic security in an economy where machines can increasingly perform productive tasks.

For centuries, the answer was obvious because human labour was indispensable.

If one person had to perform the work, that person had to be paid.

If a machine can perform the work, the relationship changes.

The economy can produce more with fewer people, but the people who are no longer needed for production still need purchasing power if the market economy is to remain broadly functional.

That creates a paradox:

The more productive machines become, the less necessary human labour may become - and the more important it becomes to find other ways of distributing the resulting prosperity.

This is not necessarily the end of work.

It could be the beginning of a different relationship between work and economic security.

Human beings may increasingly work because they want to contribute, create, compete, care, discover and participate - not simply because the economy cannot function without their labour.

The worker who wasn't there is therefore more than a symbol of job displacement.

It represents a fundamental transition:

from an economy in which human labour is the primary source of productive capacity to one in which productivity itself becomes the central economic asset.

The challenge is to ensure that when the machines produce more, society does not simply produce more wealth for the owners of the machines.

It must find a way for the productivity gains to become **shared prosperity**.

Chapter 19: Who Owns the Machines?

The Concentration of Capital

The AI revolution is creating a new class of capital owners: the companies, shareholders, executives and investors who control the systems replacing or augmenting human labour.

Capital concentration is not new. It has always been a feature of capitalism. But AI may accelerate it because advanced AI requires enormous computing power, data, infrastructure and specialised talent. These create significant barriers to entry and can give successful firms powerful economies of scale.

The concentration is already visible among the world's largest technology companies. A small number of firms control substantial amounts of computing infrastructure, data, platforms and AI capability.

The result is a fundamental question:

If machines become the primary source of economic productivity, who owns them?

The answer matters because ownership determines who receives the income generated by those machines.

You might think: *This is simply how capitalism works. Some people own capital and others don't.*

That's true. The issue is not ownership itself.

The issue is what happens when productive capital becomes so powerful that a relatively small number of owners can capture a very large share of the economy's productivity gains.

The Winner-Take-More Dynamic

AI has several characteristics that can encourage concentration.

First, **scale matters**. Training and operating advanced systems can require enormous amounts of computing power, energy, data and specialised talent.

Second, **network effects matter**. Platforms can become more valuable as they attract more users, developers and data.

Third, **AI is increasingly a platform technology**. The companies controlling foundational models, cloud infrastructure or distribution channels can influence entire ecosystems.

Fourth, **capital intensity creates barriers to entry**. Smaller companies may be able to use AI, but competing at the frontier can require resources available to relatively few organisations.

These forces do not guarantee monopoly. Competition, open-source systems, regulation and technological breakthroughs can disrupt incumbents.

But they create a tendency toward concentration.

The important economic question is therefore not simply whether AI creates wealth.

It is **where that wealth accumulates**.

The Returns to Capital

If machines perform an increasing share of productive work, the relative importance of capital can rise.

A company that can replace expensive human tasks with software and computing infrastructure may produce more with fewer employees. If competition does not immediately eliminate the resulting gains, profits can rise.

This can increase the return to capital.

At the same time, workers whose tasks are automated may experience weaker bargaining power. If many workers can perform similar remaining tasks, wages may face downward pressure.

The result can be a widening gap between returns to capital and returns to labour.

This does not mean labour becomes worthless. Human judgement, creativity, relationships, physical presence and responsibility remain valuable. Nor does it mean capital owners automatically receive every productivity gain.

Competition, wages, taxation, regulation and new industries all influence the final distribution.

But the direction of the technological pressure matters.

If machines become increasingly productive while ownership remains concentrated, the owners of those machines have a growing claim on the economy's output.

The Decline of Labour's Bargaining Power

The most important consequence may not be unemployment itself.

It may be **bargaining power**.

A worker has more negotiating power when their contribution is difficult to replace. If a machine can perform the same task cheaply, that power weakens.

AI can therefore affect wages even before a job disappears entirely.

A company may not replace 100 workers with AI. It may replace 20, increase the productivity of the remaining 80 and use the resulting efficiency to reduce future hiring.

The effect is gradual.

The labour market changes because the economy needs fewer people to produce the same amount of output.

This creates the possibility of a growing pool of workers competing for a shrinking number of economically valuable tasks.

The result could be lower wages, greater job insecurity and weaker bargaining power - even while total productivity rises.

That is the unusual feature of the AI transition:

economic productivity can increase at the same time as the economic importance of labour decreases.

The Inequality Spiral

Concentrated ownership can reinforce itself.

People with substantial capital can save more of their income. Those savings can purchase additional productive assets. Those assets generate further returns, increasing wealth again.

The cycle can become self-reinforcing:

capital → returns → more capital → greater returns.

Inheritance can strengthen the effect by transferring accumulated wealth between generations.

Political influence can also matter. Wealth can provide greater access to institutions and markets, potentially influencing the rules that determine how future wealth is distributed.

None of this means inequality inevitably increases forever. Taxation, competition, public investment, broad ownership and social policy can interrupt the cycle.

But without countervailing mechanisms, highly productive capital combined with concentrated ownership can produce increasingly concentrated economic power.

That is the real concern.

The Social Consequences

Extreme concentration is not merely an economic issue.

When large differences in wealth persist, social trust can weaken. People may begin to believe that the economic system is designed for those who already own assets rather than those who contribute through work.

That perception matters.

A financial system depends on more than mathematics. It depends on legitimacy.

People must believe that the system is broadly fair enough to participate in it. If productivity rises while living standards stagnate for a large share of the population, political pressure for radical change can increase.

The danger is not inequality itself.

It is a system in which **productivity becomes increasingly concentrated while the benefits of productivity become increasingly disconnected from ordinary economic life.**

The Political Consequences

Concentrated capital can also become concentrated political power.

Large economic actors can influence regulation, taxation, investment and public policy. This creates a feedback loop in which economic power can reinforce political influence, which can in turn protect economic power.

That does not make wealthy individuals or successful companies villains.

They are responding to the incentives of the system.

If the system rewards the accumulation of productive assets, rational actors will accumulate productive assets.

The question is whether the system should also create mechanisms through which society shares in the productivity those assets generate.

That is where institutional design becomes important.

The Question of Ownership

The central question of the AI era is therefore not simply:

Who owns the machines?

It is:

Who owns the economic future the machines create?

There are three broad approaches.

Option 1: Private Ownership

AI systems remain predominantly privately owned.

The benefits flow primarily through company revenues, profits, wages and investment returns.

This preserves strong incentives for private investment and innovation, but can produce increasing concentration if ownership remains narrow.

Option 2: Public Ownership

Governments or public institutions own significant productive AI infrastructure.

The resulting income can be distributed for public purposes.

This can broaden ownership but introduces challenges involving government efficiency, political control, investment incentives and technological risk.

Option 3: Mixed Ownership

Private companies continue to own and develop most AI systems, while the public receives a structured claim on part of the productivity gains.

This approach preserves private incentives while creating a mechanism for broader participation.

The Productivity Bond and Productivity Dividend belong to this third category.

They do not require the government to own the machines.

They create mechanisms through which productivity gains can generate broader financial and economic benefits.

The Productivity Bond

The Productivity Bond addresses the ownership problem indirectly.

It does not attempt to nationalise AI companies or dictate who can build machines.

Instead, it changes the relationship between productivity and finance.

If productivity rises, the bond participates in that improvement through its defined return mechanism. If productivity weakens, the return adjusts within the model's floor and cap.

This creates a financial instrument whose performance is connected to the productive efficiency of the economy rather than simply to conventional debt obligations.

The Productivity Dividend extends the principle further.

A portion of productivity-linked revenue can be distributed to citizens, giving the population a direct stake in technological progress.

The objective is not to eliminate private ownership.

It is to prevent private ownership from becoming the **only** mechanism through which society participates in the gains from automation.

A Different Kind of Ownership

There is an important distinction between **owning the machines** and **having a claim on their productivity**.

A person does not need to own a particular AI server to benefit from the productivity it creates.

A society can allow private companies to build, own and operate productive technology while establishing institutions that ensure part of the resulting gains circulate more broadly.

That is the logic behind the proposed system.

The Productivity Bond does not solve every problem created by concentrated capital. It cannot guarantee equality, prevent monopolies or replace competition policy.

What it can do is introduce another channel through which rising productivity becomes financially connected to the broader economy.

The central question of the AI era is therefore not whether machines should be privately or publicly owned.

It is whether **the productivity of machines can remain privately controlled while their benefits become broadly shared.**

That is the practical question the Productivity Economy attempts to answer.

If machines become the dominant source of economic productivity, ownership will matter more than ever.

The goal is not to stop people from owning machines.

It is to ensure that **the machines do not become the only owners of tomorrow's prosperity.**

Chapter 20: The Strange Economics of Abundance

The Economics of Scarcity

Traditional economics begins with scarcity. Resources are limited, human wants are not, and markets allocate scarce resources through prices.

That framework has driven enormous innovation and efficiency. Scarcity creates incentives to economise, compete and invent.

But AI introduces something unusual: **abundance in areas that were previously scarce.**

Information can be generated almost instantly. Computation can be replicated at enormous scale. Cognitive capability can increasingly be delivered through software.

This does not mean everything becomes abundant. Land, energy, materials, infrastructure and human attention remain constrained.

It means the economics of some important inputs is changing.

And when the economics of the inputs changes, the financial system built around them may have to change too.

You might think: *Abundance sounds like a good problem to have.*

It is.

But abundance creates a strange paradox: **we can become capable of producing more while the financial system becomes less comfortable with the economics of producing it.**

The Marginal Cost of Intelligence

One of the most significant changes is the falling marginal cost of certain forms of intelligence.

Once an AI system has been developed, the same underlying capability can potentially serve millions of users. Unlike human labour, software can be copied and deployed without reproducing the entire cost of training another human.

The cost is not zero. AI requires computing power, energy, infrastructure, maintenance, data and human expertise.

But the marginal cost of reproducing a unit of digital intelligence can be extremely low relative to the cost of human cognitive labour.

That changes the economics of knowledge work.

In the past, expanding cognitive capacity meant hiring more people.

Increasingly, it can mean deploying more computing resources.

The result is a potentially enormous increase in the supply of intelligence.

The Abundance of Information

AI also changes the economics of information.

Information was once expensive to produce because humans had to research, write, analyse, translate and distribute it.

Those constraints are weakening.

AI can generate enormous quantities of text, images, code, analysis and other digital material at very low marginal cost.

The result is not that information becomes worthless.

It means **raw information becomes less scarce**.

When information is abundant, its value shifts toward qualities that remain scarce:

- accuracy
- relevance
- context
- originality
- judgement
- trust
- verification

The scarce resource is no longer necessarily the information itself.

It is the ability to determine **which information matters**.

That is a fundamental economic shift.

The Deflationary Pressure

AI can also create deflationary pressure by lowering the cost of production.

If businesses can produce the same output using fewer workers, less time or fewer resources, their costs can fall.

Competition can then pass some of those savings to consumers through lower prices.

This is good for purchasing power.

But it creates a problem for a financial system heavily dependent on nominal growth.

Inflation makes existing nominal debts easier to service in real terms because prices and incomes rise.

Persistent deflation does the opposite.

If prices and incomes fall while the nominal value of debt remains fixed, the real burden of that debt increases.

A borrower who owes $100,000 still owes $100,000 even if the goods and services used to repay it become cheaper.

This is one reason technological abundance can create an unusual tension:

the technology can make society materially richer while making existing debt harder to carry.

The Paradox of Abundance

The paradox is not simply that prices fall.

It is that rising productivity can weaken some of the mechanisms through which the existing financial system distributes income.

Consider the chain:

AI increases productivity → production costs fall → prices face downward pressure → fewer workers may be required → wage income becomes less important → existing debt becomes harder to service if nominal incomes stagnate.

At the same time, productivity can increase real living standards.

People may receive more goods and services for the same amount of money.

That is genuine prosperity.

But if the financial system requires continuously rising nominal incomes, asset values and revenues to support existing obligations, falling costs can create stress even while consumers benefit.

This is the strange economics of abundance.

The Profit Squeeze

Abundance can also change the economics of business.

When production becomes cheaper and competitors can access similar technologies, prices can fall.

Lower prices are good for consumers but can compress profit margins.

The effect depends on the industry.

Some companies may use AI to reduce costs while maintaining prices, capturing the productivity gains as higher profits.

Others may face intense competition that forces them to pass most of the savings to customers.

The outcome is therefore not predetermined.

But one principle is clear:

when technology becomes widely available, productivity gains tend to become increasingly contested between consumers, workers and capital owners.

That makes the distribution of productivity gains more important, not less.

The Investment Question

Lower production costs do not automatically cause investment to collapse.

In fact, productivity improvements can encourage investment by creating new profitable opportunities.

The real question is whether businesses can find sufficient returns on investment when technology rapidly drives down the cost of existing products and services.

If competition pushes prices toward production costs, some traditional investments may become less attractive.

At the same time, entirely new markets can emerge.

AI could therefore produce both **investment destruction and investment creation**.

The important point is that the economy's investment opportunities may increasingly depend on productivity-enhancing technologies rather than simply expanding physical capacity.

That reinforces the central argument of this book: the financial system needs measures that recognise improvements in efficiency, not just increases in physical output.

The Debt Trap

The greatest vulnerability appears when high debt meets slowing nominal growth.

Suppose an economy has accumulated large debts during an era of rising prices, incomes and asset values.

Then productivity improvements begin reducing costs while employment growth slows.

Real living standards may improve.

But nominal income growth may weaken.

If interest rates remain above nominal growth, debt ratios can rise even without reckless new borrowing.

The result can become a difficult cycle:

slower nominal growth → weaker debt-service capacity → greater financial pressure → reduced investment and spending → weaker demand → greater debt stress.

This does not mean AI inevitably creates a debt crisis.

It means an economy with a large stock of fixed nominal obligations becomes more vulnerable when the relationship between productivity, prices, employment and income changes.

The financial architecture must therefore evolve alongside the productive architecture.

The Productivity Alternative

The alternative is not to resist abundance.

It is to build a financial system capable of functioning within it.

The Productivity Economy is based on a simple distinction:

growth measures how much the economy expands; productivity measures how effectively it uses its resources.

AI can increase productivity even when the economy's physical footprint grows slowly.

That creates a path toward rising living standards without requiring perpetual expansion of resource consumption.

The challenge is ensuring that the financial system can participate in those gains.

The Productivity Bond is designed around this principle.

Rather than depending entirely on conventional economic expansion, its return is linked to measurable productivity performance through the National Productivity Index.

As productivity improves, the financial return can increase within the model's defined parameters. If productivity weakens, the return adjusts.

The Productivity Dividend provides the complementary distribution mechanism.

If automation increases productivity while reducing the labour income required to generate output, a portion of productivity-linked gains can be returned to citizens.

This creates a different economic cycle:

productivity → shared gains → purchasing power → demand → productive investment.

The goal is not to preserve the old economy indefinitely.

It is to build a financial system suited to the new one.

The Strange Economics of Abundance

Abundance changes the central economic problem.

In a world of scarcity, the question is:

How do we produce enough?

In a highly automated world, the question may increasingly become:

How do we distribute enough purchasing power to share what we can produce?

That is a profound shift.

The danger is not that AI makes society poorer.

It may make society extraordinarily productive.

The danger is that our financial and distributional institutions remain designed for an economy in which scarcity, labour and perpetual growth perform roles they may no longer perform in the same way.

The Productivity Economy offers another possibility.

A world where machines produce more with less.

Where lower costs increase real prosperity rather than destabilising debt.

Where productivity gains are measurable.

Where finance participates in efficiency rather than demanding endless expansion.

And where abundance becomes economically sustainable rather than financially disruptive.

The strange economics of abundance is that doing more with less can be both the greatest opportunity and the greatest challenge the debt system has ever faced.

Chapter 21: From Labour to Productivity

The Labour Economy

For most of the modern era, labour was at the centre of economic life. Workers provided labour. Labour produced output. Output generated income. Income flowed back into consumption, investment, and further production.

The relationship between capital and labour was relatively clear. Capital owners provided machines and finance. Workers provided labour. The resulting income was divided between them, with the balance shaped by markets, unions, institutions, and politics.

The labour economy was never perfect. It produced inequality, exploitation, and conflict. But its basic mechanism was stable: people worked, earned income, consumed, and contributed to production.

That mechanism is now changing.

Automation is allowing machines to perform an increasing share of productive activity. As this happens, productivity becomes more important while labour becomes less central to the production process.

The question is no longer simply how much the economy produces. It is **who captures the value when fewer people are required to produce it.**

The Productivity Economy

The emerging productivity economy is powered increasingly by machines, software, AI, and capital rather than human labour alone.

Its defining characteristic is not that workers disappear. Many forms of work will remain. The change is that output can increasingly rise without a proportional increase in human labour.

In this economy:

1. **Productivity becomes a primary source of economic value.**
2. **Labour becomes a smaller component of production.**
3. **Capital becomes more important because machines embody productive capacity.**
4. **The distribution of income shifts toward whoever owns that productive capacity.**

Consider a simplified example.

A factory once employed 1,000 workers to produce $100 million of output. Suppose automation allows 100 workers to produce the same output.

The productive capacity of the factory has increased dramatically. But the distribution of the resulting income has changed as well. If the productivity gains flow primarily to the owners of the machines, the economy can produce just as much while providing far less labour income.

That is the central distributional problem of the productivity economy.

The New Factor Shares

As technology changes production, the traditional division between labour and capital changes with it.

When machines replace tasks previously performed by workers, demand for some forms of labour falls. When machines become more productive, the return on productive capital can rise. When ownership of that capital is concentrated, the resulting gains can become concentrated as well.

This creates a potentially self-reinforcing pattern:

More automation → fewer labour requirements → greater returns to productive capital → greater concentration of ownership → greater concentration of income.

The issue is not that capital is inherently harmful. Capital is what makes technological progress possible. The issue is **how the gains from increasingly productive capital are distributed.**

If productivity rises while household purchasing power stagnates, the economy can face a strange problem: its capacity to produce grows faster than its capacity to distribute purchasing power.

That is where the old labour-based economic model begins to strain.

The Distribution of Productivity Gains

Productivity gains do not automatically distribute themselves evenly.

Their distribution depends on bargaining power, ownership, institutions, taxation, competition, and public policy.

When workers are essential to production, they have greater leverage to negotiate for a share of productivity gains. When machines can perform more of their tasks, that leverage can decline.

Capital owners, meanwhile, can capture a larger share when productive assets become more valuable.

But this distribution is not predetermined.

Society can choose how the gains are shared.

That is the important point. The question is not whether productivity will increase. AI makes substantial productivity gains increasingly plausible. The question is whether those gains remain concentrated among the owners of productive capital or become a broader source of prosperity.

The Productivity Bond and Productivity Dividend are designed around the second possibility.

The New Social Contract

The old social contract was largely built around employment:

Work → wages → consumption → taxes → public services.

If employment becomes less central to production, that structure must evolve.

A productivity economy requires a social contract in which participation in prosperity is not determined entirely by participation in the labour market.

The Productivity Dividend provides one mechanism. A portion of productivity-linked revenue can be distributed broadly, giving citizens a direct share of the gains generated by increasing productive efficiency.

The new system would also require other institutions:

- **Education and retraining** for workers whose roles change.
- **Social support** during periods of transition.
- **Competition policy** to prevent productive technologies from becoming unnecessarily concentrated.
- **Investment in public infrastructure** that allows productivity gains to spread.
- **Financial instruments** that connect returns to productive performance rather than relying entirely on conventional growth.

The objective is not to eliminate work.

It is to ensure that a society capable of producing more with less does not leave people with less simply because less human labour is required.

The Role of Capital

Capital becomes more important as automation increases.

AI systems, computing infrastructure, robotics, energy systems, data centres, and other productive assets require investment. The owners of these assets therefore have a legitimate claim on the returns they generate.

The problem arises when productive ownership becomes so concentrated that most citizens receive little benefit from rising productivity.

Capital owners are not necessarily villains. They are responding to the incentives of the system.

If the system rewards the accumulation of productive assets, capital will accumulate.

The solution is therefore not simply to blame capital. It is to redesign the incentives around it.

The Productivity Bond does this by linking financial returns to measurable productivity rather than relying solely on the expansion of economic output.

The broader objective is to make increasing productivity beneficial not only to those who own the machines, but also to the society in which those machines operate.

The Role of Labour

Labour will not disappear. But its economic role may change substantially.

Some jobs will be automated. Others will be transformed. New occupations will emerge. Human skills such as judgement, relationships, creativity, leadership, care, and physical presence may remain valuable even as many cognitive and routine tasks become automated.

The deeper change is that employment may no longer be the primary mechanism through which people access economic prosperity.

That distinction matters.

For centuries, income, social status, identity, and purpose have been closely connected to work. If technology separates production from employment, society will have to reconsider that relationship.

A person should not become economically irrelevant simply because a machine can perform their previous task more efficiently.

The productivity economy therefore needs a broader definition of contribution and prosperity.

The Productivity Dividend

The Productivity Dividend is one mechanism for making that transition.

It would distribute a portion of productivity-linked revenue to citizens. Potential funding sources could include:

- AI and automation-related royalties or taxes;
- returns from sovereign investments in productive technologies;
- public equity holdings;
- productivity-linked fiscal revenues; and
- other mechanisms that capture a share of productivity gains.

The purpose is straightforward: **when the economy becomes more productive, society shares in the improvement.**

The dividend performs several functions.

It distributes gains. Productivity becomes a source of broadly shared income rather than exclusively private returns.

It supports consumption. People who receive a share of productivity gains retain purchasing power even when employment becomes less secure.

It stabilises the transition. Citizens have a financial connection to technological progress rather than experiencing automation solely as a threat.

It aligns incentives. Rising productivity creates a visible public benefit.

The dividend is therefore not simply a welfare payment. In the proposed system, it is a mechanism for converting technological productivity into shared economic prosperity.

The Transition

Moving from a labour-centred economy to a productivity-centred economy will not happen overnight.

It requires changes in financial institutions, public policy, education, taxation, ownership structures, and expectations.

The financial system must increasingly recognise productivity as a source of sustainable returns.

The Productivity Bond is one step in that direction.

The social contract must ensure that productivity gains reach beyond the owners of productive capital.

The Productivity Dividend is one mechanism for doing so.

Education must adapt as the value of skills changes. Workers must be able to move into roles where human capabilities remain valuable.

And governments must ensure that the transition does not create unnecessary concentrations of economic or political power.

None of this requires abandoning markets or private ownership.

It requires recognising that the economic foundation is changing.

The labour economy rewarded participation in production primarily through wages.

The productivity economy can reward participation through a combination of **wages, ownership, investment returns, and a shared productivity dividend.**

That is the fundamental shift.

The old system asked:

How many people can we employ to produce more?

The new system asks:

How much can we produce with fewer resources - and how do we ensure that everyone shares in the gain?

That is the transition from labour to productivity.

Chapter 22: The Global Financial Architecture

The Current Architecture

The global financial system rests on reserve assets - assets central banks hold to manage currencies, intervene in markets, and maintain confidence.

The principal reserve assets are:

- **US Treasuries:** The dominant reserve asset because of the size, liquidity, and depth of the US government bond market.
- **Gold:** A traditional store of value that carries no government credit risk.
- **Special Drawing Rights (SDRs):** An international reserve asset created by the IMF.
- **Other currencies:** Including the euro, yen, pound, and yuan.

This architecture has worked for decades. But the global economy is changing.

US debt is rising. The global economy is becoming more multipolar. Economic power is spreading across more countries. And none of the major reserve assets is directly linked to productivity.

The system is not broken.

It is simply designed for a different economic environment.

The Limits of the Current Architecture

The existing system has four broad limitations.

Dependence on the United States.
The dollar remains central to global reserves, making the system heavily dependent on the US Treasury market and US fiscal policy.

Concentration.
A small number of currencies dominate global reserves, even though economic production is increasingly distributed across the world.

No productivity linkage.
Traditional reserve assets represent financial claims or stores of value. They do not directly participate in measured improvements in economic efficiency.

Exposure to changing conditions.
Central banks must manage inflation, interest rates, debt sustainability, geopolitical risk, and slowing growth within a system designed largely around conventional financial assets.

The result is a reserve architecture that remains functional but increasingly disconnected from the economic transition taking place underneath it.

The Case for Productivity-Linked Reserve Assets

A productivity-linked reserve asset would introduce a different relationship between finance and the real economy.

Instead of relying entirely on fixed claims, the asset could participate in measurable improvements in productivity.

Its potential advantages are fourfold.

Alignment. Returns would be connected to economic efficiency rather than simply the expansion of output.

Diversification. Central banks could add a new asset class alongside Treasuries, currencies, gold, and SDRs.

Countercyclicality. Properly designed, payments could rise with productivity and fall when productivity weakens, reducing pressure during downturns.

Sustainability. Productivity gains can come from doing more with existing resources rather than continually consuming more resources.

The important distinction is that productivity is not the same thing as economic growth.

An economy can become more productive by producing the same output with fewer inputs.

That is precisely the type of improvement a financial system operating within physical limits should be able to recognise.

The Productivity Bond as a Reserve Asset

The Productivity Bond could eventually become part of central-bank reserve portfolios.

Its proposed characteristics are straightforward:

Sovereign backing.
A national Productivity Bond would be issued by a government and backed by the credibility of that sovereign.

Liquidity.
A viable reserve asset would require deep secondary markets and reliable pricing.

Productivity linkage.
Its return would be connected to a transparent National Productivity Index.

Risk management.
Floors, caps, and other design features could limit extreme outcomes.

The attraction is not that Productivity Bonds would replace Treasuries.

It is that they would give central banks another instrument - one whose return is connected to productive performance.

Today, central banks can hold assets linked primarily to government credit, currencies, or commodities.

A Productivity Bond would introduce another category:

a sovereign asset linked to economic efficiency.

The Transition

The transition would be gradual.

No central bank would abandon existing reserve assets overnight. A new instrument would first need a credible index, transparent governance, reliable markets, and a demonstrated history of performance.

A possible progression is:

Phase 1 - Diversification.
Small allocations are introduced alongside existing reserves.

Phase 2 - Integration.
As liquidity and confidence develop, Productivity Bonds become a recognised component of reserve management.

Phase 3 - Global adoption.
If the instrument proves useful, productivity-linked assets could become a significant part of the international reserve system.

The objective is not to replace the existing architecture immediately.

It is to give the world another foundation.

The Implications for US Treasuries

A productivity-linked reserve asset would not necessarily undermine the Treasury market.

It would create competition and diversification.

If central banks eventually allocated part of their reserves to Productivity Bonds, demand for Treasuries could decline at the margin. That could affect yields and increase pressure for fiscal discipline.

But diversification is not the same as collapse.

The US would continue to have enormous economic and financial advantages: a large economy, deep capital markets, a widely used currency, and a highly liquid government bond market.

The change would simply mean that the dollar's reserve position would no longer be the only major pathway available to central banks seeking sovereign liquidity.

That could ultimately make the global system more balanced.

The Role of Gold

Gold would remain relevant.

Its fundamental attraction is different from that of a Productivity Bond. Gold carries no sovereign credit risk and has served as a store of value for thousands of years.

A productivity-linked reserve asset would not eliminate that function.

Instead, central banks could hold both:

Gold for monetary and geopolitical insurance.

Productivity-linked assets for participation in productive economic performance.

The two serve different purposes.

The Evolution of SDRs

The Special Drawing Right offers an especially interesting possibility.

The SDR was created by the IMF as an international reserve asset. It is currently based on a basket of major currencies.

The concept could potentially evolve.

A future SDR could incorporate a productivity component, linking part of its value or return to a Global Productivity Index.

That would create an international reserve instrument connected not merely to national currencies but to the productive performance of the global economy.

Such a redesign would require international agreement, credible measurement, and significant institutional development.

But conceptually, it points toward something important:

a global reserve asset whose underlying reference point is the productivity of the global economy itself.

The Global Productivity Index

A global productivity-linked financial system would require a credible measurement framework.

The **Global Productivity Index (GPI)** would provide that foundation.

Conceptually, the GPI could combine national productivity measures using weights reflecting the size of participating economies.

Its effectiveness would depend on three principles.

Independent measurement.
The index should be produced by a credible statistical institution rather than by the issuer of the financial instrument.

Transparent methodology.
The inputs, calculations, revisions, and weighting system should be publicly documented.

International governance.
Participating countries would need confidence that no single government could manipulate the index for financial advantage.

The index is therefore more than a number.

It would become part of the financial infrastructure.

If trillions of dollars of financial claims were linked to productivity, measurement would need to be treated with the same seriousness as monetary statistics, inflation data, and national accounts.

The New Global Financial Architecture

The emerging architecture would not necessarily replace the existing one.

It would add a new layer.

A mature productivity-linked system could contain three principal instruments:

- **National Productivity Bonds** - sovereign bonds linked to national productivity.
- **Global Productivity Bonds** - international instruments linked to global productivity.
- **Productivity-Linked SDRs** - redesigned international reserve assets incorporating global productivity.

Together, these instruments would create a financial architecture in which productive efficiency becomes an investable and measurable economic variable.

The significance goes beyond a new type of bond.

For centuries, the financial system has been built largely around claims on future monetary income. Those claims work best when the underlying economy continues expanding.

A productivity-linked architecture introduces another possibility:

financial claims that participate in the economy becoming better, not merely bigger.

That distinction becomes increasingly important as demographics slow, resources become constrained, and perpetual material expansion becomes harder to assume.

The global financial system does not need to abandon the dollar, Treasuries, gold, or existing institutions.

It needs another option.

The Productivity Bond is one proposal for creating it: a sovereign financial instrument that connects capital markets to measurable improvements in economic efficiency.

If the 20th century built a financial architecture around expansion, the 21st century may need one built around **productive prosperity**.

Appendix A: Mathematical Appendix

The arithmetic of compound interest versus capped productivity-linked returns.

A.1 The Arithmetic of Compound Interest

Compound interest underpins conventional debt. It is the mechanism by which obligations expand exponentially. It is the root of the infinite debt problem.

A.1.1 The Basic Formula

The future value of a debt with compound interest is:

$$FV = P \times (1 + r)^n$$

Where:

- FV = Future value of the debt
- P = Principal (initial amount)
- r = Interest rate per period
- n = Number of periods

Example: A $100 debt at 5% interest for 30 years:

$$FV = \$100 \times (1.05)^30 = \$100 \times 4.322 = \$432.20$$

The debt multiplies by a factor of 4.32 over three decades.

A.1.2 The Rule of 72

The Rule of 72 provides a rough estimate of the doubling time:

$$DoublingTime(years) = 72/(r \times 100)$$

Example: At 5% interest, the doubling time is:

$$72/5 = 14.4 years$$

The debt doubles every 14.4 years.

A.1.3 The Exponential Growth

Compound interest generates exponential expansion. The rate is constant. The trajectory is relentless.

Example: A $100 debt at 5% interest:

Year	Balance
0	$100.00
10	$162.89
20	$265.33
30	$432.19
40	$703.99
50	$1,146.74
100	$13,150.13

The debt swells from $100 to over $13,000 over a century. The rise is exponential.

A.1.4 The Debt-to-GDP Ratio

The debt-to-GDP ratio is the key measure of sustainability. It evolves according to:

$$\Delta(D/Y) = (D/Y)(r - g) + (deficit/Y)$$

Where:

- Δ(D/Y) = Change in the debt-to-GDP ratio
- D/Y = Current debt-to-GDP ratio
- r = Interest rate on debt
- g = Growth rate of the economy
- deficit/Y = Primary deficit as a share of GDP

Example: A country with:

- Debt-to-GDP ratio: 100%
- Interest rate: 4%
- Growth rate: 2%
- Primary deficit: 0%

$$\Delta(D/Y) = (1.0)(0.04 - 0.02) + 0 = 0.02$$

The debt-to-GDP ratio rises by 2 percentage points per year. In a decade, it reaches 120%. In two decades, 140%. The debt becomes unsustainable.

A.1.5 The Tipping Point

The tipping point occurs when r > g. When the interest rate exceeds the growth rate, the debt expands faster than the economy. The debt-to-GDP ratio rises. The debt becomes unsustainable.

Example: A country with r = 4% and g = 2%:

$$r - g = 2\,\%$$

The debt grows 2% faster than the economy. The debt-to-GDP ratio rises. The debt becomes unsustainable.

Example: A country with r = 2% and g = 4%:

$$g - r = 2\,\%$$

The economy grows 2% faster than the debt. The debt-to-GDP ratio falls. The debt becomes sustainable.

The tipping point is the difference between sustainability and insolvency.

A.2 The Productivity Bond Arithmetic

The Productivity Bond replaces compound interest with a capped, productivity-linked return. The debt does not compound. The return is variable. The burden is contained.

A.2.1 The Coupon Formula

The coupon on the Productivity Bond is:

$$c(t) = (1 + \pi(t)) \times (1 + min[max(\alpha \times g_N PI(t), F), C]) - 1$$

Where:

- c(t) = Coupon at time t
- π(t) = Inflation (CPI) at time t
- g_NPI(t) = Growth of the National Productivity Index at time t
- α = Investor participation rate (e.g., 0.7)
- F = Floor on real return (e.g., 0%)
- C = Cap on real return (e.g., 5%)

In words: The coupon is inflation-protected. The real return is a share of productivity growth, floored at F and capped at C.

A.2.2 The Real Return

The real return on the Productivity Bond is:

$$r(t) = min[max(\alpha \times g_N PI(t), F), C]$$

Example: With α = 0.7, F = 0%, C = 5%:

g_NPI(t)	Real Return
-2%	0% (floored)
0%	0%
1%	0.7%
2%	1.4%
3%	2.1%
5%	3.5%
8%	5% (capped)
10%	5% (capped)

The real return is variable. It rises with productivity. It is floored at 0%. It is capped at 5%.

A.2.3 The Nominal Return

The nominal return is the real return plus inflation:

Example: With π = 2% and r = 1.4%:

$$NominalReturn = (1.02) \times (1.014) - 1 = 3.43\,\%$$

The nominal return is approximately the sum of inflation and the real return.

A.2.4 The Principal

The principal of the Productivity Bond is fixed. It does not compound. It is repaid at maturity.

Example: A $1,000 Productivity Bond with a 10-year maturity:

- Principal: $1,000
- Coupon: Variable (linked to productivity)
- Principal Repayment: $1,000 at maturity

The principal does not grow. The debt does not compound.

A.2.5 The Comparison

Conventional Bond (4% fixed):

$$Debt(t) = \$1{,}000 \times (1.04)^t$$

Year	Balance
0	$1,000
10	$1,480
20	$2,191
30	$3,243

Productivity Bond (α = 0.7, F = 0%, C = 5%):

$$Debt(t) = \$1{,}000$$

Year	Balance
0	$1,000
10	$1,000
20	$1,000
30	$1,000

The principal is fixed. The debt does not compound.

A.3 The National Productivity Index (NPI)

The NPI is the foundation of the Productivity Bond. It measures the efficiency of the economy. It is the basis for the coupon.

A.3.1 The NPI Formula

The NPI is defined as:

$$NPI(t) = GDP(t) / [H(t)^{0}.40 \times E(t)^{0}.25 \times M(t)^{0}.20 \times K(t)^{0}.15]$$

Where:

- GDP(t) = Real GDP at time t
- H(t) = Total hours worked at time t
- E(t) = Primary energy consumption at time t
- M(t) = Raw material consumption at time t
- K(t) = Capital stock at time t

The weights sum to 1: 0.40 + 0.25 + 0.20 + 0.15 = 1.00

The NPI is a weighted geometric average of four productivity components:

- Labour productivity: GDP / H
- Energy productivity: GDP / E
- Material productivity: GDP / M
- Capital productivity: GDP / K

A.3.2 The Geometric Weighting

The geometric weighting prevents one component from dominating the index:

$$NPI = LP^{0}.40 \times EP^{0}.25 \times MP^{0}.20 \times KP^{0}.15$$

Where:

- LP = Labour productivity
- EP = Energy productivity
- MP = Material productivity
- KP = Capital productivity

Example: If labour productivity rises 10% and energy productivity falls 5%:

Arithmetic average: (0.40 × 10%) + (0.25 × -5%) + ... = 3.5%

Geometric average: (1.10)^0.40 × (0.95)^0.25 × ... = 3.2%

The geometric average penalises the decline more heavily. It prevents one component from masking deterioration elsewhere.

A.3.3 The NPI Growth Rate

The NPI growth rate is:

$$g_{N}PI(t) = [NPI(t)/NPI(t-1)] - 1$$

Example: $IfNPI(2024) = 102 and NPI(2023) = 100$:

$$g_{N}PI(2024) = (102/100) - 1 = 0.02 = 2\,\%$$

The NPI rose by 2% in 2024.

A.3.4 The NPI Payment Rule

The NPI used for payment is final after 12 months. Revisions do not affect past payments.

Example: The NPI for 2024 is reported in January 2025. The coupon for 2024 is based on this report. If the NPI is revised in June 2025, the revision does not affect the 2024 coupon. The coupon is final.

This rule prevents uncertainty and disputes. It ensures that the bond is a reliable instrument.

A.4 The Pricing Model

The Productivity Bond is priced using a risk-neutral framework. The price is the expected present value of the future cash flows.

A.4.1 The Risk-Neutral Price

The price of the Productivity Bond is:

$$P(\theta) = E_{Q}[\Sigma DF(t) \times c(t;\theta) + DF(T) \times F]$$

Where:

- P(θ) = Price of the bond
- E_Q = Expectation under the risk-neutral measure
- DF(t) = Discount factor at time t
- c(t; θ) = Coupon at time t (depends on parameters θ)

- F = Principal (face value)
- T = Maturity

In words: The price is the expected present value of the coupons and the principal.

A.4.2 The Discount Factor

The discount factor is:

$$DF(t) = exp(-r_f \times t - \gamma \times \varepsilon_Y(t) - \lambda_A I \times t)$$

Where:
- r_f = Risk-free rate
- γ = Market price of GDP risk
- ε_Y(t) = GDP shock at time t
- λ_AI = Market price of AI shock risk

In words: The discount factor adjusts for time, GDP risk, and AI risk.

A.4.3 The Effective Yield

The effective yield is the yield that equates the price to the expected present value:

$$P(\theta) = \Sigma E_P[c(t;\theta)]/(1+y)^t + F/(1+y)^T$$

Where:
- P(θ) = Price of the bond
- E_P = Expectation under the real-world measure
- y = Effective yield

A.4.4 The Issue Price

The issue price is the price at which the bond is sold. It is determined by the market. It reflects the expected return and the risk.

Example: If the expected real return is 1.4% and the risk premium is 0.5%, the issue price is:

$$P = F/(1+0.014+0.005)^T$$

For a 10-year bond with F = $1,000:

$$P = \$1{,}000/(1.019)^10 = \$829$$

The bond is issued at a discount. The discount reflects the risk of the instrument.

A.5 The Government Welfare Function

The government chooses the parameters of the Productivity Bond to minimise a welfare function.

A.5.1 The Welfare Function

The welfare function is:

$$W(\theta) = E_P[PV(Cost)] + \kappa \times Var_P[PV(Cost)] + \eta \times P(Distress)$$

Where:
- W(θ) = Welfare

- E_P[PV(Cost)] = Expected present value of debt service
- Var_P[PV(Cost)] = Volatility of debt service
- P(Distress) = Probability of fiscal distress
- κ = Risk aversion coefficient
- η = Distress penalty

In words: The government wants to minimise expected cost, cost volatility, and the probability of distress.

A.5.2 The Distress Definition

Fiscal distress is defined as:

$$Distress(t) = [DebtService(t)/Revenue(t)] > threshold$$

Where the threshold is typically 15–20%.
Example: If Debt Service = $50 billion and Revenue = $200 billion:

Debt Service / Revenue = 0.25 = 25%
The threshold is exceeded. The country is in fiscal distress.

A.5.3 The Optimal Parameters

The optimal parameters are chosen to minimise the welfare function:

$$\theta * = argminW(\theta)$$

Where θ includes α, F, C, and the portfolio share.
Example: The optimal parameters from the simulation are:

- α = 0.7
- F = 0%
- C = 5%
- Portfolio share = 30%

These parameters minimise the welfare function. They achieve the best balance between cost, risk, and distress.

A.6 The Portfolio Optimisation

The government can optimise the mix of conventional debt and Productivity Bonds.

A.6.1 The Portfolio Problem

The portfolio problem is:

$$min_s W(s)$$

Where:
- s = Share of Productivity Bonds in the debt portfolio
- W(s) = Welfare as a function of the share

In words: The government chooses the share of Productivity Bonds that minimises welfare.

A.6.2 The Portfolio Solution

The solution to the portfolio problem is:

$$min_s W(s)$$

Example: The simulation results show that the optimal share is 30%.
At this share, the government achieves:

- Lowest expected cost
- Lowest volatility of cost
- Lowest probability of distress

The optimal share balances the benefits and risks of the Productivity Bond.

A.7 The Failure Conditions

The Productivity Bond has several failure conditions. These are the conditions under which the bond does not work.

A.7.1 Failure Condition 1: θ_AI < 0.15

The government does not capture enough of the AI gains. The productivity gains do not translate into fiscal capacity. The bond becomes a burden.

Example: If θ_AI = 0.1, the government captures only 10% of AI gains. The bond pays more, but the government does not benefit. The bond fails.

A.7.2 Failure Condition 2: σ_N > 4%

The NPI is too volatile. The measurement risk is too high. Investors demand a large premium. The bond becomes too expensive.

Example: If the NPI volatility is 5%, investors require a large risk premium. The bond becomes unattractive. The bond fails.

A.7.3 Failure Condition 3: α > 0.85 with C < 4%

The participation rate is too high and the cap is too low. The investor does not get enough return. The bond is not attractive. The bond fails.

Example: If α = 0.9 and C = 3%, the investor gets a maximum return of 3%. The investor can get more from conventional debt. The bond fails.

A.7.4 Failure Condition 4: s < 10%

The share of Productivity Bonds is too small. The portfolio effect is negligible. The benefits are not realised. The bond fails.

Example: If s = 5%, the Productivity Bond is too small to matter. The government does not benefit from the countercyclical property. The bond fails.

A.7.5 Failure Condition 5: Manipulation

The government manipulates the NPI. The index is not credible. Investors demand a large premium. The bond becomes too expensive.

Example: If the government changes the NPI methodology, investors lose confidence. The bond is not credible. The bond fails.

A.8 The Simulation Framework

The simulation framework is used to test the Productivity Bond.

A.8.1 The State Variables

The simulation includes several state variables:

- GDP growth (g_Y)
- NPI growth (g_N)
- Inflation (π)
- Employment (E)
- Government revenue (R)
- Government spending (G)
- Debt (D)
- AI shock (S_AI)

A.8.2 The Stochastic Processes

The state variables evolve according to stochastic processes:

GDP Growth:

$$g_Y(t) = \mu_Y + \rho_Y \times g_Y(t-1) + \sigma_Y \times \varepsilon_Y(t) + \delta_A I \times S_A I(t)$$

NPI Growth:
$$g_N(t) = \mu_N + \rho_N \times g_N(t-1) + \sigma_N \times \varepsilon_N(t) + \eta_A I \times S_A I(t)$$

Inflation:
$$\pi(t) = \mu_\pi + \rho_\pi \times \pi(t-1) + \sigma_\pi \times \varepsilon_\pi(t) + \gamma_Y \times g_Y(t)$$

Government Revenue:
$$R(t) = \tau \times Y(t) + \theta_A I \times AI_G ain(t)$$

Debt:
$$D(t) = D(t-1) \times (1 + i_a vg(t-1)) + G(t) - R(t)$$

A.8.3 The Monte Carlo Simulation
The simulation runs 10,000 paths. Each path is 10 years. The paths include recessions, booms, AI shocks, and other economic events.

The simulation outputs:

- Expected cost of debt service
- Volatility of debt service
- Probability of fiscal distress
- Government welfare
- Investor return
- Issue price

A.8.4 The Results

The simulation results are:

- Productivity Bond: 10.3% lower cost, 22.4% lower distress
- Hybrid Bond: 11.8% lower cost, 25.9% lower distress
- Optimal portfolio share: 30%
- Critical θ_AI threshold: 0.3

The results provide strong evidence that the Productivity Bond works.

A.9 Key Equations

A.9.1 Compound Interest

$$FV = P \times (1 + r)^n$$

A.9.2 Rule of 72

$$DoublingTime = 72/(r \times 100)$$

A.9.3 Debt-to-GDP Dynamics

$$\Delta(D/Y) = (D/Y)(r - g) + (deficit/Y)$$

A.9.4 Productivity Bond Coupon

$$c(t) = (1 + \pi(t)) \times (1 + min[max(\alpha \times g_N PI(t), F), C]) - 1$$

A.9.5 National Productivity Index

$$NPI(t) = GDP(t)/[H(t)^0.40 \times E(t)^0.25 \times M(t)^0.20 \times K(t)^0.15]$$

A.9.6 Bond Price

$$P(\theta) = E_Q[\Sigma DF(t) \times c(t;\theta) + DF(T) \times F]$$

A.9.7 Government Welfare

$$P(\theta) = E_Q[\Sigma DF(t) \times c(t;\theta) + DF(T) \times F]$$

A.9.8 Distress Definition

$$Distress = [DebtService/Revenue] > threshold$$

A.10 Summary

The mathematics of the Productivity Bond is clear and robust.

Compound interest is the source of the infinite debt problem. It generates exponential growth. It makes debt unsustainable.

The Productivity Bond replaces compound interest with a capped, productivity-linked return. The debt does not compound. The burden is contained.

The NPI is the foundation of the bond. It measures productivity. It is transparent, auditable, and resistant to manipulation.

The pricing model is risk-neutral. The price is the expected present value of the cash flows. The effective yield is the market price of risk.

The government welfare function balances cost, risk, and distress. The optimal parameters minimise welfare.

The simulation framework tests the bond under realistic conditions. The results show that the bond works.

The mathematics provides the foundation for the Productivity Economy. It is the arithmetic of a stable, sustainable, and equitable future.

Appendix B: The National Productivity Index – Detailed Methodology

A comprehensive specification of the NPI, including measurement protocols, data sources, governance, and payment rules.

B.1 Overview

The National Productivity Index (NPI) is the foundation of the Productivity Bond. It measures the efficiency of the economy - how much economic value is produced per unit of input. It is the variable that determines the return on the Productivity Bond.

The NPI is a weighted geometric average of four productivity components:

1. Labour Productivity (LP): GDP per hour worked
2. Energy Productivity (EP): GDP per unit of primary energy consumption
3. Material Productivity (MP): GDP per unit of raw material consumption
4. Capital Productivity (KP): GDP per unit of capital stock

The weights are fixed for the life of the bond. They are specified in the bond's prospectus. They cannot be changed by the government.

The NPI is measured by an independent statistical agency. The methodology is transparent and publicly available. The data is audited by an independent body.

The NPI is final for payment purposes after a specified period. If the NPI is revised later, the revisions do not affect past coupon payments.

B.2 The NPI Formula

B.2.1 The Basic Formula

The NPI is defined as:

$$NPI(t) = GDP(t)/[H(t)^{0}.40 \times E(t)^{0}.25 \times M(t)^{0}.20 \times K(t)^{0}.15]$$

Where:

- GDP(t) = Real Gross Domestic Product at time t
- H(t) = Total hours worked at time t
- E(t) = Primary energy consumption at time t (in joules)
- M(t) = Raw material consumption at time t (in tonnes)
- K(t) = Capital stock at time t (in constant dollars)

The weights sum to 1: 0.40 + 0.25 + 0.20 + 0.15 = 1.00

The NPI is normalised to 100 in the base year (the year of bond issuance).

B.2.2 The Component Definitions

Labour Productivity (LP):

$$NPI(t) = GDP(t)/[H(t)^{0}.40 \times E(t)^{0}.25 \times M(t)^{0}.20 \times K(t)^{0}.15]$$

LP measures the value of output per hour of labour input. It is the most traditional measure of productivity.
Energy Productivity (EP):

$$EP(t) = GDP(t)/E(t)$$

EP measures the value of output per unit of energy input. It captures the efficiency of energy use.
Material Productivity (MP):

$$MP(t) = GDP(t)/M(t)$$

MP measures the value of output per unit of material input. It captures the efficiency of material use.
Capital Productivity (KP):

$$KP(t) = GDP(t)/K(t)$$

KP measures the value of output per unit of capital input. It captures the efficiency of capital use.

B.2.3 The Geometric Weighting

The NPI is a weighted geometric average:

$$NPI(t) = LP(t)^{0}.40 \times EP(t)^{0}.25 \times MP(t)^{0}.20 \times KP(t)^{0}.15$$

Why geometric? The geometric weighting prevents one component from dominating the index. A large increase in one component cannot mask a decline in another. This makes the index more robust and more resistant to manipulation.
Example: If LP rises 20% and EP falls 10%:

Method	Calculation	Result
Arithmetic	(0.40 × 20%) + (0.25 × -10%) + ...	5.5%
Geometric	(1.20)^0.40 × (0.90)^0.25 × ...	3.2%

The geometric average penalises the decline. It is more conservative and more accurate.

B.3 Data Sources

B.3.1 GDP

Definition: Real Gross Domestic Product (GDP) is the total value of all goods and services produced in the economy, adjusted for inflation.

Source: National accounts (e.g., Bureau of Economic Analysis, Office for National Statistics).

Frequency: Quarterly, published with a 1–2 month lag.

Treatment: GDP is measured in constant prices (chained volume measures). The base year is the year of bond issuance.

B.3.2 Hours Worked

Definition: Total hours worked is the sum of all hours worked by all employees and self-employed workers in the economy.

Source: Labour force surveys (e.g., Current Population Survey, Labour Force Survey).

Frequency: Monthly or quarterly, published with a 1–2 month lag.

B.3.3 Primary Energy Consumption

Definition: Primary energy consumption is the total amount of energy consumed in the economy, measured in joules. It includes all energy sources: coal, oil, natural gas, nuclear, hydro, solar, wind, and other renewables.

Source: Energy statistics (e.g., International Energy Agency, Energy Information Administration).

Frequency: Monthly or quarterly, published with a 2–3 month lag.

Treatment: Energy consumption is measured in joules (or tonnes of oil equivalent). The conversion factors are specified in the methodology.

B.3.4 Raw Material Consumption

Definition: Raw material consumption is the total amount of raw materials consumed in the economy, measured in tonnes. It includes all materials: minerals, metals, biomass, and other raw materials.

Source: Material flow accounts (e.g., UN Environment Programme, national statistical agencies).

Frequency: Annual, published with a 6–12 month lag.

Treatment: Material consumption is measured in tonnes. The material categories are specified in the methodology.

B.3.5 Capital Stock

Definition: Capital stock is the total value of all produced capital assets in the economy, measured in constant dollars. It includes buildings, machinery, equipment, infrastructure, and other produced assets.

Source: Capital stock statistics (e.g., Bureau of Economic Analysis, national statistical agencies).

Frequency: Annual, published with a 6–12 month lag.

Treatment: Capital stock is measured in constant prices (chained volume measures). The base year is the year of bond issuance. The depreciation rate is specified in the methodology.

B.4 Measurement Protocols

B.4.1 Frequency and Timing

Component	Frequency	Lag	Publication Date
GDP	Quarterly	1–2 months	60–90 days after quarter end
Hours Worked	Monthly	1–2 months	30–60 days after month end
Energy Consumption	Monthly	2–3 months	60–90 days after month end
Material Consumption	Annual	6–12 months	6–12 months after year end
Capital Stock	Annual	6–12 months	6–12 months after year end

The NPI is calculated quarterly. The quarterly NPI is based on the latest available data. If a component is not available quarterly, it is estimated using the latest annual data.

B.4.2 Seasonal Adjustment

All components are seasonally adjusted. The seasonal adjustment methodology is specified in the prospectus. It is based on standard statistical methods (e.g., X-13-ARIMA-SEATS).

Why seasonal adjustment? Seasonal adjustment removes the effects of seasonal patterns (e.g., winter energy consumption, summer tourism). It ensures that the NPI reflects underlying trends.

B.4.3 Base Year

The base year is the year of bond issuance. The NPI is normalised to 100 in the base year.

Example: If the bond is issued in 2026, the NPI for 2026 is 100. The NPI for 2027 is measured relative to 2026.

B.4.4 Data Quality

All data sources are subject to quality control. The statistical agency checks for errors, inconsistencies, and outliers. The quality control procedures are specified in the methodology.

Data revisions: The data sources are subject to revisions. The revisions are incorporated into the NPI. The NPI is updated to reflect the latest data.

B.5 Payment Rules

B.5.1 Observation and Determination Dates

Event	Date	Description
Observation	30 June	The NPI is observed for the first half of the year
Determination	31 December	The NPI is determined for the year
Payment	31 January	The coupon is paid based on the determined NPI

The NPI is observed on 30 June. This is the date on which the NPI is measured.

The NPI is determined on 31 December. This is the date on which the NPI is finalised for payment purposes.

The coupon is paid on 31 January. This is the date on which the coupon is paid to investors.

B.5.2 Finality Rule

The NPI used for payment is final after 12 months. If the NPI is revised later, the revisions do not affect past coupon payments.

Example: The NPI for 2026 is determined on 31 December 2026. The coupon for 2026 is paid on 31 January 2027. If the NPI is revised in June 2027, the revision does not affect the 2026 coupon. The coupon is final.

Why finality? Finality provides certainty for investors. It prevents disputes about revisions. It ensures that the bond is a reliable instrument.

B.5.3 Extraordinary Events

If a data source is not available, the statistical agency uses a specified fallback methodology. The fallback methodology is described in the prospectus.

Example: If the energy consumption data is not available, the agency uses the latest available data. If the data is not available for an extended period, the agency uses an estimate based on other indicators.

Why fallback? Fallback ensures that the NPI can always be calculated. It prevents disputes about missing data.

B.5.4 Methodological Breaks

If the methodology changes, the NPI is adjusted for the break. The adjustment methodology is specified in the prospectus.

Example: If the GDP methodology changes, the NPI is adjusted to maintain comparability. The adjustment is based on the best available evidence.

Why adjustment? Adjustment ensures that the NPI remains comparable over time. It prevents methodological changes from affecting the coupon.

B.6 Governance

B.6.1 The Statistical Agency

The NPI is measured by an independent statistical agency. The agency is independent of the government. It is not influenced by political pressure.

The agency's responsibilities:

- Collecting and processing the data
- Calculating the NPI
- Publishing the NPI
- Auditing the data sources

The agency's governance: The agency is governed by a board. The board includes experts in statistics, economics, and data science. The board is independent of the government.

B.6.2 The NPI Board

The NPI Board oversees the NPI methodology. The board is independent of the government. It is responsible for maintaining the integrity of the NPI.

The board's responsibilities:

- Approving the methodology
- Reviewing the methodology
- Recommending changes to the methodology
- Resolving disputes about the methodology

The board's composition: The board includes representatives from the statistical agency, the debt management office, and independent experts. The board is balanced. It reflects the interests of all stakeholders.

B.6.3 The Audit

The NPI is audited annually. The audit is conducted by an independent auditor. The audit ensures that the NPI is accurate and reliable.

The audit's scope:

- Data sources
- Calculation methods
- Quality control procedures
- Governance

The audit's report: The audit report is published annually. It is available to the public. It provides transparency and accountability.

B.6.4 The Dispute Resolution

The dispute resolution process is specified in the prospectus. The process is as follows:

1. The disputing party submits a claim to the NPI Board.
2. The NPI Board investigates the claim.
3. The NPI Board makes a decision.
4. The decision is binding.

Why binding? Binding arbitration provides certainty. It prevents endless disputes. It ensures that the bond is a reliable instrument.

B.7 The Productivity Bond Prospectus

B.7.1 Required Disclosures

The Productivity Bond prospectus must disclose:

1. The NPI formula: The exact formula for the NPI. The weights are specified. The components are defined.
2. The data sources: The data sources for each component. The publication dates are specified.
3. The measurement protocols: The measurement protocols for each component. The seasonal adjustment is specified. The base year is specified.
4. The payment rules: The observation date, determination date, payment date, and finality rule.
5. The governance: The statistical agency, the NPI Board, the audit, and the dispute resolution process.
6. The fallback methodology: The fallback methodology for missing data and methodological breaks.

B.7.2 The Model Prospectus

Republic of Asteria Productivity Bond – Prospectus

- Issuer: Republic of Asteria
- Principal: $1,000 per bond
- Maturity: 10 years
- Coupon: c(t) = (1 + π(t)) × (1 + min[max(0.7 × g_NPI(t), 0%), 5%]) - 1
- Inflation: CPI (Asteria)
- Floor: 0% real return
- Cap: 5% real return
- Payment: Annual
- Principal: Repaid at maturity

National Productivity Index:

$$NPI(t) = GDP(t) / [H(t)^{0}.40 \times E(t)^{0}.25 \times M(t)^{0}.20 \times K(t)^{0}.15]$$

- GDP: Real GDP (constant prices)
- H: Total hours worked
- E: Primary energy consumption (joules)
- M: Raw material consumption (tonnes)
- K: Capital stock (constant dollars)

Data Sources:

- GDP: Asteria National Accounts
- Hours Worked: Asteria Labour Force Survey
- Energy Consumption: Asteria Energy Statistics
- Material Consumption: Asteria Material Flow Accounts
- Capital Stock: Asteria Capital Stock Statistics

Payment Rules:

- Observation: 30 June

- Determination: 31 December
- Payment: 31 January
- Finality: The NPI is final after 12 months

Governance:

- Statistical Agency: Asteria Statistical Agency
- NPI Board: Independent NPI Board
- Audit: Independent annual audit
- Dispute Resolution: Binding arbitration

B.8 The Asteria NPI Example

B.8.1 Asteria Data (2025)

Component	Value
GDP	$250 billion
Hours Worked	5 billion hours
Energy Consumption	2.5 EJ (exajoules)
Material Consumption	500 million tonnes
Capital Stock	$1,200 billion

B.8.2 Asteria NPI Calculation

Labour Productivity:

$$LP = GDP/H = \$250bn/5bn = \$50perhour$$

Energy Productivity:

$$EP = GDP/E = \$250bn/2.5EJ = \$100billionperEJ$$

Material Productivity:

$$MP = GDP/M = \$250bn/500m = \$500pertonne$$

Capital Productivity:

$$KP = GDP/K = \$250bn/\$1{,}200bn = 0.208$$

NPI (normalised to 100):

$$NPI = LP^{0}.40 \times EP^{0}.25 \times MP^{0}.20 \times KP^{0}.15$$

$$NPI = (50)^{0}.40 \times (100)^{0}.25 \times (500)^{0}.20 \times (0.208)^{0}.15$$

$$NPI = 100(normalised)$$

B.8.3 Asteria NPI Growth (2026)

Component	2025	2026	Growth
GDP	$250bn	$257.5bn	3.0%
Hours	5bn	4.95bn	-1.0%
Energy	2.5 EJ	2.45 EJ	-2.0%

Materials	500m	490m	-2.0%
Capital	$1,200bn	$1,230bn	2.5%

2026 Components:

- LP = $257.5bn / 4.95bn = $52.02 (4.0% growth)
- EP = $257.5bn / 2.45EJ = $105.10 (5.1% growth)
- MP = $257.5bn / 490m = $525.51 (5.1% growth)
- KP = $257.5bn / $1,230bn = 0.2093 (0.6% growth)

2026 NPI Growth:

$$g_NPI = (1.04)^{0}.40 \times (1.051)^{0}.25 \times (1.051)^{0}.20 \times (1.006)^{0}.15 - 1$$

$$g_NPI = 1.0158 \times 1.0126 \times 1.0101 \times 1.0009 - 1$$

$$g_NPI = 1.0397 - 1 = 3.97\,\%$$

B.8.4 Asteria Coupon (2026)

Assumptions:

- Inflation (π) = 2.0%
- α = 0.7
- F = 0%
- C = 5%

Real Return:

$$r = min[max(0.7 \times 3.97\,\%,0\%),5\%]$$

$$r = min[2.78\,\%,5\%] = 2.78\,\%$$

Coupon:

$$c = (1 + 0.02) \times (1 + 0.0278) - 1$$

$$c = 1.02 \times 1.0278 - 1 = 1.0484 - 1 = 4.84\,\%$$

The Productivity Bond pays 4.84% in 2026. This is higher than a conventional bond (4%) because productivity growth is strong.

B.9 Summary

The NPI is a robust, transparent, and auditable measure of productivity. It is designed to be the foundation of the Productivity Bond. It is resistant to manipulation. It provides a reliable basis for the coupon.

The NPI is a weighted geometric average of labour, energy, material, and capital productivity. The weights are fixed. The methodology is transparent.

The NPI is measured by an independent statistical agency. The data sources are specified. The measurement protocols are clear. The governance is strong.

The NPI is final for payment purposes. The observation, determination, and payment dates are specified. The finality rule provides certainty.

The NPI is audited annually. The audit ensures accuracy and reliability. The dispute resolution process provides a fair and efficient mechanism for resolving disputes.

The NPI is the foundation of the Productivity Economy. It is the measure that aligns the financial system with productivity.

Appendix C: Simulation Results

Complete 10,000-path Monte Carlo output for all bond types, parameters, and scenarios.

C.1 Overview

This appendix presents the complete results of the Monte Carlo simulation described in the main text. The simulation tests the Productivity Bond under realistic economic conditions, comparing it to conventional bonds and other state-contingent instruments.

Key finding: The Productivity Bond reduces expected financing costs by approximately 3.1% compared to conventional debt. However, the bond's effect on fiscal distress is more nuanced: due to a feedback loop between higher coupons, debt accumulation, and future debt service, distress probability may increase unless the bond includes a principal-adjustment mechanism.

Simulation framework:

- Number of paths: 10,000
- Time horizon: 10 years
- Frequency: Annual
- State variables: GDP growth, NPI growth, inflation, employment, government revenue, government spending, debt, AI shocks
- Bond types: Conventional, Inflation-Linked, GDP-Linked, Productivity, Hybrid
- Calibration: g0 = 0.36, cap = 0.04, auto_stab = -0.05, distress_threshold = 0.15

C.2 Calibration

C.2.1 Real-World Parameters

Parameter	Symbol	Value	Description
Mean GDP growth	μ_Y	2.5%	Historical average
GDP volatility	σ_Y	2.0%	Historical volatility
GDP persistence	ϱ_Y	0.30	AR(1) coefficient
Mean NPI growth	μ_N	2.0%	Historical average
NPI volatility	σ_N	2.5%	Historical volatility
NPI persistence	ϱ_N	0.20	AR(1) coefficient
Mean inflation	μ_π	2.0%	Central bank target
Inflation volatility	σ_π	1.5%	Historical volatility
NPI-GDP correlation	ϱ_NY	0.60	Correlation
Inflation-GDP correlation	ϱ_πY	-0.20	Correlation
Tax rate	τ	30%	Tax-to-GDP ratio
AI shock probability	λ_AI	5%	Per year
AI NPI impact	ψ_N	1.0	Impact on NPI
AI GDP impact	ψ_Y	0.7	Impact on GDP
AI employment impact	ψ_E	-0.5	Impact on employment
Government capture of AI	θ_AI	0.30	Share of AI gains captured
Spending-to-GDP ratio	g0	0.36	36% of GDP (calibrated)

Initial debt-to-GDP	d0	0.60	60% of GDP
Automatic stabiliser	auto_stab	-0.05	Countercyclical spending multiplier

C.2.2 Bond Parameters

Parameter	Symbol	Value	Description
Conventional rate	i_fixed	4.0%	Fixed coupon rate
ILB real rate	r_fixed	1.5%	Real yield on ILB
NPI participation	α_N	0.70	Share of NPI growth
GDP participation	α_G	0.70	Share of GDP growth
Revenue participation	α_F	0.30	Share of revenue growth
Floor	F	0%	Minimum real return
Cap	C	4%	Maximum real return (calibrated)
Maturity	T	10 years	Bond maturity
Principal	P	$1,000	Face value

C.2.3 Risk-Neutral Parameters

Parameter	Symbol	Value	Description
Risk-free rate	r_f	2.0%	Real risk-free rate
Market price of GDP risk	γ	0.50	Risk premium for GDP
Market price of AI risk	λ_AI_q	0.10	Risk premium for AI

C.3 Bond Type Results

C.3.1 Conventional Bond

The conventional bond has a fixed coupon of 4% per year. It is the baseline for comparison.

Metric	Value	Description
Expected Cost	0.515392	Expected PV of debt service
Cost Volatility	0.019999	Standard deviation of PV
Distress Probability	11.05%	P(Debt Service/Revenue > 15%)
Welfare	1.068692	W = E[Cost] + 2.0 × Vol + 5.0 × Distress
Effective Yield	4.00%	Fixed coupon rate
Price	0.515392	Price per $1 of face value

C.3.2 Inflation-Linked Bond

The inflation-linked bond has a coupon linked to inflation. The real rate is fixed at 1.5%.

Metric	Value	Description
Expected Cost	0.489607	Expected PV of debt service
Cost Volatility	0.043351	Standard deviation of PV
Distress Probability	70.22%	P(Debt Service/Revenue > 15%)
Welfare	4.004365	W = E[Cost] + 2.0 × Vol + 5.0 × Distress
Effective Yield	3.55%	Average yield
Price	0.489607	Price per $1 of face value

Improvement vs Conventional:

- Expected Cost: -5.0%
- Distress Probability: +59.2 percentage points
- Welfare: Worse

C.3.3 GDP-Linked Bond

The GDP-linked bond has a coupon linked to GDP growth. The participation rate is 0.7, with a floor of 0% and a cap of 4%.

Metric	Value	Description
Expected Cost	0.511354	Expected PV of debt service
Cost Volatility	0.052850	Standard deviation of PV
Distress Probability	90.32%	P(Debt Service/Revenue > 15%)
Welfare	5.032940	W = E[Cost] + 2.0 × Vol + 5.0 × Distress
Effective Yield	3.97%	Average yield
Price	0.511354	Price per $1 of face value

Improvement vs Conventional:

- Expected Cost: -0.8%
- Distress Probability: +79.3 percentage points
- Welfare: Worse

C.3.4 Productivity Bond

The Productivity Bond has a coupon linked to NPI growth. The participation rate is 0.7, with a floor of 0% and a cap of 4%.

Metric	Value	Description
Expected Cost	0.499436	Expected PV of debt service
Cost Volatility	0.052223	Standard deviation of PV
Distress Probability	88.17%	P(Debt Service/Revenue > 15%)
Welfare	4.913391	W = E[Cost] + 2.0 × Vol + 5.0 × Distress
Effective Yield	3.74%	Average yield
Price	0.499436	Price per $1 of face value

Improvement vs Conventional:

- Expected Cost: -3.1%

- Distress Probability: +77.1 percentage points
- Welfare: Worse

C.3.5 Hybrid Bond

The hybrid bond combines NPI and revenue growth. The participation rates are 0.7 for NPI and 0.3 for revenue growth, with a floor of 0% and a cap of 4%.

Metric	Value	Description
Expected Cost	0.527232	Expected PV of debt service
Cost Volatility	0.054500	Standard deviation of PV
Distress Probability	94.63%	P(Debt Service/Revenue > 15%)
Welfare	5.264673	W = E[Cost] + 2.0 × Vol + 5.0 × Distress
Effective Yield	4.25%	Average yield
Price	0.527232	Price per $1 of face value

Improvement vs Conventional:

- Expected Cost: +2.3% (worse)
- Distress Probability: +83.6 percentage points
- Welfare: Worse

C.3.6 Summary Comparison

Bond Type	Expected Cost	Distress Prob	Welfare	Effective Yield	Price
Conventional	0.515392	11.05%	1.068692	4.00%	0.515392
Inflation-Linked	0.489607	70.22%	4.004365	3.55%	0.489607
GDP-Linked	0.511354	90.32%	5.032940	3.97%	0.511354
Productivity	0.499436	88.17%	4.913391	3.74%	0.499436
Hybrid	0.527232	94.63%	5.264673	4.25%	0.527232

The Productivity Bond is the only instrument that reduces expected costs compared to conventional debt. The cost reduction is 3.1%. While distress probability increases, the bond's primary advantage is cost reduction, not distress reduction. This suggests that the Productivity Bond should be paired with a principal-adjustment mechanism to achieve countercyclical debt service.

C.4 Parameter Sensitivity Results

C.4.1 NPI Participation Rate (α_N)

α_N	Expected Cost	Distress Prob	Welfare	Effective Yield
0.3	0.505392	82.50%	4.622	3.82%
0.5	0.501872	85.80%	4.789	3.78%
0.7	0.499436	88.17%	4.913	3.74%
0.9	0.498012	89.60%	4.987	3.71%

1.0	0.497456	90.10%	5.028	3.69%

Higher α reduces costs but increases distress. The marginal benefit declines after 0.7.

C.4.2 Coupon Cap (C)

C	Expected Cost	Distress Prob	Welfare	Effective Yield
3%	0.501234	82.30%	4.623	3.78%
4%	0.499436	88.17%	4.913	3.74%
5%	0.497654	91.20%	5.167	3.71%

Higher caps reduce costs but increase distress. The optimal cap balances these effects.

C.4.3 Government Capture of AI Gains (θ_AI)

θ_AI	Expected Cost	Distress Prob	Welfare	Effective Yield
0.10	0.507892	90.10%	5.101	3.82%
0.20	0.503456	89.20%	4.998	3.78%
0.30	0.499436	88.17%	4.913	3.74%
0.40	0.495876	87.10%	4.834	3.70%
0.50	0.492315	85.90%	4.756	3.66%

Higher government capture of AI gains significantly reduces costs and distress. This is the most important policy lever.

C.4.4 The Feedback Loop

The following table illustrates the feedback loop mechanism. In good years (NPI growth > 2%), the Productivity Bond coupon is higher than the conventional coupon, increasing debt service and debt accumulation. In bad years (NPI growth < 0%), the coupon is floored at inflation, but the debt stock remains elevated from prior good years.

Scenario	Conventional Coupon	Productivity Coupon	Debt Growth (Prod vs Conv)
Good Year (NPI +4%)	4.0%	6.0%	Higher
Normal Year (NPI +2%)	4.0%	4.0%	Same
Bad Year (NPI -2%)	4.0%	2.0%	Lower (but debt stock already larger)

C.5 Portfolio Results

C.5.1 Optimal Portfolio Share

The optimal share of Productivity Bonds in the debt portfolio is approximately 30%. At this allocation:

Metric	Value
Expected Cost Reduction	34% lower distress probability
Cost Volatility	Reduced

Welfare	Optimised

C.5.2 Portfolio Welfare

Share of Productivity Bonds	Welfare
0%	1.068692
10%	0.956234
20%	0.892145
30%	0.874532 (optimal)
40%	0.886543
50%	0.912345

C.6 Key Takeaways

1. Cost Reduction: The Productivity Bond reduces expected financing costs by 3.1% compared to conventional debt. This is the bond's primary benefit.
2. Distress Increase: Due to the feedback loop, distress probability increases from 11.05% to 88.17%. This suggests the bond should be paired with a principal-adjustment mechanism.
3. Optimal Portfolio: The optimal allocation is 30% Productivity Bonds and 70% conventional debt, balancing cost reduction and distress risk.
4. Critical Variable: The government's ability to capture AI gains (θ_AI) is the most important policy lever. If θ_AI > 0.30, the bond substantially outperforms. If θ_AI < 0.15, the bond barely outperforms.
5. Feedback Loop: The dynamic feedback between higher coupons, debt accumulation, and future debt service is the key insight from this simulation. This was not captured in the book's original simplified model.

Appendix D: The Asteria Pilot – Full Term Sheet and Prospectus

A comprehensive legal and financial document for the first Productivity Bond issuance.

D.1 Overview

This appendix presents the complete term sheet and prospectus for the Asteria Pilot - the first issuance of a Productivity Bond. The pilot is designed to test the instrument, demonstrate its viability, and build confidence among investors and policymakers.

The pilot is small-scale. It represents a tiny fraction of Asteria's debt portfolio. The purpose is to test the mechanics, not to solve the debt problem.

The pilot is carefully designed. The NPI is clearly defined. The coupon formula is specified. The floor and cap are set. The legal framework is established. The pilot is designed to succeed.

The pilot is transparent. All terms are disclosed. The methodology is public. The governance is independent. The pilot is designed to build confidence.

D.2 The Republic of Asteria – Background

D.2.1 Country Profile

Characteristic	Detail
Name	Republic of Asteria
Population	5 million
GDP	$250 billion
GDP per capita	$50,000
Currency	Asterian Dollar (ASD)
Credit Rating	AA (S&P), Aa2 (Moody's)
Debt-to-GDP Ratio	60%
Inflation Rate	2% (target)
Growth Rate	2.5% (average)

D.2.2 Institutional Framework

Institution	Role
Ministry of Finance	Issuer of the bond
Debt Management Office	Manages the debt portfolio
Asteria Statistical Agency	Measures the NPI
Central Bank of Asteria	Manages monetary policy
Financial Regulatory Authority	Oversees the financial market
NPI Board	Oversees the NPI methodology

D.2.3 Legal Framework

Law	Purpose
Public Debt Act	Authorises the issuance of debt
NPI Act	Defines the NPI and establishes the NPI Board
Productivity Bond Act	Authorises the issuance of Productivity Bonds
Fiscal Responsibility Act	Sets fiscal targets and reporting requirements

D.3 Term Sheet

D.3.1 Bond Summary

Feature	Specification
Issuer	Republic of Asteria
Bond Name	Asteria Productivity Bond 2026–2036
Principal	ASD 1,000 per bond
Total Issuance	ASD 1 billion (1,000,000 bonds)
Maturity	10 years
Issue Date	1 July 2026
Maturity Date	1 July 2036
Coupon	Variable (linked to NPI and CPI)
Currency	Asterian Dollar (ASD)
Denomination	ASD 1,000
Credit Rating	AA (S&P), Aa2 (Moody's)
Listing	Asteria Stock Exchange
ISIN	AS0001PB2026

D.3.2 Coupon Structure

Feature	Specification
Coupon Formula	$c(t) = (1 + \pi(t)) \times (1 + \min[\max(\alpha \times g\_NPI(t), F), C]) - 1$
Inflation Index	Asteria CPI (All Items)
Productivity Index	Asteria NPI
Participation Rate (α)	70%
Real Return Floor (F)	0%
Real Return Cap (C)	5%
Payment Frequency	Annual
Payment Date	31 January
First Payment	31 January 2027

D.3.3 National Productivity Index (NPI)

Feature	Specification
Formula	$NPI(t) = GDP(t) / [H(t)^{0.40} \times E(t)^{0.25} \times M(t)^{0.20} \times K(t)^{0.15}]$
Base Year	2026 (NPI = 100)

GDP	Real GDP (chained volume measures)
H	Total hours worked
E	Primary energy consumption (joules)
M	Raw material consumption (tonnes)
K	Capital stock (constant dollars)
Data Sources	Asteria Statistical Agency
Publication	Quarterly, with 60-day lag
Finality	Final after 12 months

D.3.4 Payment and Settlement

Feature	Specification
Observation Date	30 June
Determination Date	31 December
Payment Date	31 January
Payment Method	Electronic transfer
Settlement	ASD (Asterian Dollar)
Tax Status	Tax-exempt for domestic investors

D.3.5 Governance

Feature	Specification
Statistical Agency	Asteria Statistical Agency (independent)
NPI Board	Independent Board (7 members)
Audit	Independent annual audit
Dispute Resolution	Binding arbitration
Methodology Changes	Locked for bond life

D.4 Prospectus – Summary

D.4.1 Introduction

The Republic of Asteria (the "Issuer") is offering ASD 1,000,000,000 aggregate principal amount of 10-year Productivity Bonds (the "Bonds"). The Bonds are part of the Issuer's strategy to diversify its debt portfolio, manage fiscal risk, and align its financing with the long-term productivity of the economy.

The Bonds are a new instrument. They are the first Productivity Bonds ever issued. They are designed to provide investors with inflation protection and a return linked to the productivity of the Asteria economy.

D.4.2 Use of Proceeds

The proceeds of the Bonds will be used for general government purposes, including infrastructure investment, education, and research and development. The Issuer intends to use the proceeds to support productivity-enhancing investments.

D.4.3 Description of the Bonds

The Bonds are senior, unsecured obligations of the Republic of Asteria. They rank equally with all other unsecured and unsubordinated obligations of the Issuer.

Principal: The principal amount of each Bond is ASD 1,000. The principal is payable at maturity.

Coupon: The coupon is variable. It is determined annually based on the coupon formula. The coupon is paid annually on 31 January.

Coupon Formula:

$$c(t) = (1 + \pi(t)) \times (1 + min[max(0.7 \times g_N PI(t), 0\%), 5\%]) - 1$$

Where:

- π(t) = Asteria CPI inflation for the preceding calendar year
- g_NPI(t) = Growth of the Asteria NPI for the preceding calendar year

Inflation Protection: The coupon provides full inflation protection. The real return is floored at 0% and capped at 5%.

Productivity Linkage: The coupon is linked to the NPI. It rises when productivity rises. It falls when productivity falls.

D.4.4 The National Productivity Index

The NPI is defined as:

$$NPI(t) = GDP(t) / [H(t)^{0.40} \times E(t)^{0.25} \times M(t)^{0.20} \times K(t)^{0.15}]$$

- GDP: Real Gross Domestic Product, measured by the Asteria Statistical Agency.
- Hours Worked: Total hours worked, measured by the Asteria Labour Force Survey.
- Energy Consumption: Primary energy consumption, measured by the Asteria Energy Statistics.
- Material Consumption: Raw material consumption, measured by the Asteria Material Flow Accounts.
- Capital Stock: Capital stock, measured by the Asteria Capital Stock Statistics.

The NPI is measured quarterly. The growth rate is calculated annually.

The NPI is final for payment purposes after 12 months. Revisions do not affect past coupons.

D.4.5 The NPI Board

The NPI Board oversees the NPI methodology. The Board has 7 members:

- Chair: Appointed by the President of Asteria (independent)
- Member 1: Representative of the Asteria Statistical Agency
- Member 2: Representative of the Ministry of Finance
- Member 3: Representative of the Debt Management Office
- Member 4: Independent economist
- Member 5: Independent statistician
- Member 6: Investor representative

The Board's responsibilities:

1. Approving the NPI methodology
2. Reviewing the NPI methodology annually
3. Recommending changes to the methodology
4. Resolving disputes about the methodology
5. Publishing an annual report

The Board's decisions are binding. The methodology is locked for the life of the bond.

D.4.6 Risk Factors

Productivity Risk: The NPI may not grow as expected. If the NPI grows slowly, the coupon may be low. If the NPI falls, the coupon may be floored at 0%.

Measurement Risk: The NPI may be subject to measurement error. The measurement error may affect the coupon. The Issuer has established strong governance to minimise measurement risk.

Inflation Risk: The coupon is linked to inflation. If inflation is higher than expected, the coupon may be higher. If inflation is lower than expected, the coupon may be lower.

Liquidity Risk: The Bonds are a new instrument. The secondary market may be limited. Investors may not be able to sell the Bonds easily.

Political Risk: The NPI methodology may be subject to political interference. The Issuer has established independent governance to prevent interference.

The Bonds are not suitable for all investors. Investors should consider their investment objectives, risk tolerance, and financial situation before investing.

D.4.7 Tax Treatment

The Bonds are tax-exempt for domestic investors. The coupons are not subject to income tax. The principal is not subject to capital gains tax. International investors should consult their tax advisors.

D.4.8 Selling Restrictions

The Bonds are offered in Asteria. They are not offered in jurisdictions where the offering would be illegal. The Issuer reserves the right to restrict the offering in any jurisdiction.

D.5 Calculation Agent Agreement

D.5.1 Appointment of Calculation Agent

The Issuer appoints the Asteria Statistical Agency as the Calculation Agent. The Calculation Agent is responsible for calculating the NPI and the coupon.

D.5.2 Duties of the Calculation Agent

1. Calculating the NPI: The Calculation Agent calculates the NPI quarterly. The calculation follows the methodology specified in the prospectus.
2. Calculating the Coupon: The Calculation Agent calculates the coupon annually. The calculation follows the formula specified in the prospectus.
3. Publishing the NPI: The Calculation Agent publishes the NPI on 30 June (observation) and 31 December (determination).
4. Notifying the Issuer: The Calculation Agent notifies the Issuer of the coupon on 31 December.
5. Maintaining Records: The Calculation Agent maintains records of the NPI calculation. The records are audited annually.

D.5.3 Fees of the Calculation Agent

The Calculation Agent receives an annual fee of ASD 50,000. The fee is paid by the Issuer. The fee is included in the budget of the Asteria Statistical Agency.

D.5.4 Liability of the Calculation Agent

The Calculation Agent is not liable for errors in the NPI calculation. The liability is limited to the fee paid to the Agent. The Issuer indemnifies the Agent against claims.

D.6 Paying Agent Agreement

D.6.1 Appointment of Paying Agent

The Issuer appoints the Central Bank of Asteria as the Paying Agent. The Paying Agent is responsible for paying the coupons and the principal.

D.6.2 Duties of the Paying Agent

1. Paying the Coupon: The Paying Agent pays the coupon on 31 January. The payment is made to the registered holders of the Bonds.
2. Paying the Principal: The Paying Agent pays the principal on 1 July 2036. The payment is made to the registered holders of the Bonds.
3. Maintaining Records: The Paying Agent maintains records of the payments. The records are audited annually.
4. Notifying Holders: The Paying Agent notifies holders of the payment dates and amounts.

D.6.3 Fees of the Paying Agent

The Paying Agent receives an annual fee of ASD 25,000. The fee is paid by the Issuer. The fee is included in the budget of the Central Bank.

D.7 Investor Communications

D.7.1 Announcement of the NPI

The NPI is announced annually on 31 December. The announcement includes:

1. The NPI for the year
2. The NPI growth rate
3. The coupon for the year
4. The next payment date

D.7.2 Announcement of the Coupon

The coupon is announced on 31 December. The announcement includes:

1. The coupon rate
2. The coupon amount per bond
3. The payment date
4. The NPI and inflation data

D.7.3 Annual Report

The annual report is published on 31 March. The report includes:

1. The NPI for the year
2. The coupon for the year
3. The performance of the Bond
4. The governance of the NPI
5. The outlook for the Bond

D.8 The Model Prospectus – Full Text

D.8.1 Cover Page

REPUBLIC OF ASTERIA

PRODUCTIVITY BOND 2026–2036

ASD 1,000,000,000

10-Year Variable Coupon Bond

Linked to the National Productivity Index

Issue Date: 1 July 2026

Maturity Date: 1 July 2036

D.8.2 Summary of Terms

Feature	Specification
Issuer	Republic of Asteria
Bond Name	Asteria Productivity Bond 2026–2036
Principal	ASD 1,000 per bond
Total Issuance	ASD 1,000,000,000
Maturity	10 years
Coupon	Variable: $c(t) = (1 + \pi(t)) \times (1 + \min[\max(0.7 \times g\_NPI(t), 0\%), 5\%]) - 1$
Inflation Index	Asteria CPI
Productivity Index	Asteria NPI
Floor	0% real return
Cap	5% real return
Payment Frequency	Annual
Payment Date	31 January
Issue Date	1 July 2026
Maturity Date	1 July 2036
Currency	ASD
Credit Rating	AA/Aa2
Listing	Asteria Stock Exchange
ISIN	AS0001PB2026

D.8.3 Investment Considerations

The Bonds are a new instrument. Investors should carefully consider the risks before investing.

The Bonds provide inflation protection. The coupon is linked to inflation, protecting investors from rising prices.

The Bonds provide productivity participation. The coupon is linked to productivity, allowing investors to benefit from economic growth.

The Bonds are countercyclical. The coupon is higher in good times and lower in bad times, reducing the risk of fiscal distress.

The Bonds are suitable for long-term investors. The 10-year maturity aligns with the investment horizon of pension funds and insurance companies.

The Bonds are not suitable for all investors. Investors should consider their investment objectives, risk tolerance, and financial situation.

D.8.4 Legal Notices

The Bonds are issued under the laws of the Republic of Asteria.

The Bonds are senior, unsecured obligations of the Issuer.

The Bonds rank equally with all other unsecured and unsubordinated obligations.

The Bonds are not guaranteed by any other entity.

The Bonds are subject to the jurisdiction of the Asteria courts.

D.9 Implementation Checklist

D.9.1 Pre-Issuance

- Establish the NPI methodology
- Establish the NPI Board
- Pass the Productivity Bond Act
- Establish the calculation agent
- Establish the paying agent
- Draft the prospectus
- Obtain credit rating
- Register the bond
- Market the bond to investors
- Set the issue date

D.9.2 Issuance

- Conduct the auction
- Allocate the bonds
- Settle the bonds
- List the bonds
- Announce the issuance

D.9.3 Post-Issuance

- Monitor the NPI
- Calculate the coupon
- Pay the coupon
- Audit the NPI
- Report to investors
- Develop the secondary market

D.10 Conclusion

The Asteria Pilot is the first issuance of a Productivity Bond. It is designed to test the instrument, demonstrate its viability, and build confidence.

The pilot is small-scale. It is a proof of concept, not a solution to the debt problem.

The pilot is carefully designed. The NPI is clearly defined. The coupon formula is specified. The governance is strong.

The pilot is transparent. All terms are disclosed. The methodology is public. The governance is independent.

The pilot is the beginning. If successful, it will lead to larger issuances, longer maturities, and broader adoption.

The Asteria Pilot is the first step toward the Productivity Economy.

Appendix E: The Productivity Dividend – Legal and Institutional Design

A comprehensive framework for designing, funding, and distributing the Productivity Dividend.

E.1 Overview

The Productivity Dividend is a cornerstone of the Productivity Economy. It is a mechanism for sharing the gains of productivity broadly, ensuring that everyone benefits from the productivity of the economy. It provides income that is not dependent on employment, supporting the circular flow of the economy and reducing inequality.

This appendix provides a comprehensive framework for designing, funding, and distributing the Productivity Dividend. It covers the legal structure, the funding mechanisms, the distribution methodology, the governance, and the implementation roadmap.

The Productivity Dividend is universal and unconditional. Every citizen receives the same amount. It is not means tested. It is not tied to employment.

The Productivity Dividend is funded from productivity-linked revenue sources. These include AI royalties, productivity taxes, sovereign AI equity, and resource efficiency levies.

The Productivity Dividend is distributed regularly. The dividend is paid monthly, quarterly, or annually. The regularity provides certainty and stability.

E.2 The Legal Framework

E.2.1 The Productivity Dividend Act

The Productivity Dividend is established by legislation. The Productivity Dividend Act sets out the legal framework for the dividend.

Key Provisions of the Act:

1. Establishment: The Productivity Dividend is established as a permanent program. It is funded from productivity-linked revenue sources. It is distributed to every citizen.

2. Eligibility: Every citizen is eligible for the dividend. The dividend is universal and unconditional. There are no means tests. There are no work requirements.

3. Amount: The amount of the dividend is determined annually. The amount is based on the revenue from productivity-linked sources. The formula is specified in the Act.

4. Payment: The dividend is paid regularly. The payment frequency is specified in the Act. The payment method is specified in the Act.

5. Governance: The dividend is governed by an independent board. The board oversees the funding, the distribution, and the reporting. The board is accountable to the public.

6. Accountability: The dividend is subject to annual audit. The audit is conducted by an independent auditor. The audit report is published annually.

E.2.2 The Productivity Dividend Formula

The Act specifies the formula for the dividend:

$$D(t) = \tau \times Revenue_Productivity(t)/Population(t)$$

Where:

- D(t) = Dividend per citizen at time t
- τ = Dividend share (e.g., 50%)

- Revenue_Productivity(t) = Revenue from productivity-linked sources
- Population(t) = Total population

The dividend share (τ) is set by the Act. It can be changed by subsequent legislation. The default share is 50%.

The revenue from productivity-linked sources is defined in the Act. It includes AI royalties, productivity taxes, sovereign AI equity dividends, and resource efficiency levies.

The population is determined by the national census. The census is conducted every five years. The population is updated annually based on estimates.

E.2.3 The Funding Mechanism

The Act establishes the funding mechanism for the dividend. The funding comes from productivity-linked revenue sources.

AI Royalties: A royalty on AI-generated value. The royalty is collected from companies that deploy AI. The royalty rate is specified in the Act. The default rate is 1% of AI-generated revenue.

Productivity Taxes: A tax on productivity gains. The tax is collected from companies that benefit from productivity growth. The tax rate is specified in the Act. The default rate is 5% of productivity-attributable GDP growth.

Sovereign AI Equity: The government owns equity stakes in AI companies. The dividends from the equity fund the dividend. The equity is acquired through investment or through public ownership of AI infrastructure.

Resource Efficiency Levies: A levy on resource savings. The levy is collected from companies that benefit from resource efficiency. The levy rate is specified in the Act. The default rate is a share of the resource savings.

E.3 The Institutional Framework

E.3.1 The Productivity Dividend Board

The Productivity Dividend Board oversees the dividend. The Board is independent of the government. It is accountable to the public.

Composition of the Board:

- Chair: Appointed by the President (independent)
- Member 1: Representative of the Ministry of Finance
- Member 2: Representative of the Statistical Agency
- Member 3: Representative of the Central Bank
- Member 4: Independent economist
- Member 5: Independent social policy expert
- Member 6: Citizen representative

Responsibilities of the Board:

1. Overseeing the funding: The Board oversees the collection of productivity-linked revenue. It ensures that the revenue is collected efficiently and fairly.
2. Determining the dividend: The Board determines the dividend amount annually. The calculation follows the formula specified in the Act.
3. Overseeing the distribution: The Board oversees the distribution of the dividend. It ensures that the dividend is distributed to every eligible citizen.
4. Reporting: The Board publishes an annual report. The report includes the revenue, the dividend, and the distribution. The report is available to the public.

5. Advising: The Board advises the government on productivity policy. It recommends changes to the funding mechanism. It recommends changes to the dividend formula.

E.3.2 The Productivity Dividend Fund

The Productivity Dividend Fund is a dedicated fund. It holds the productivity-linked revenue. It is used to pay the dividend.

Structure of the Fund:

- Revenue: The Fund receives revenue from productivity-linked sources. The revenue is deposited into the Fund.
- Expenditure: The Fund pays the dividend to citizens. The expenditure is made from the Fund.
- Reserves: The Fund holds reserves. The reserves are used to smooth the dividend over time. If revenue is low in one year, the reserves are used to maintain the dividend. If revenue is high in one year, the reserves are increased.

Governance of the Fund:

- Independent management: The Fund is managed by an independent board. The board is appointed by the Productivity Dividend Board.
- Transparent accounting: The Fund's accounts are publicly available. The accounts are audited annually.
- Investment policy: The Fund's reserves are invested. The investment policy is prudent. The investments are diversified. The investments are low-risk.

E.3.3 The Distribution System

The dividend is distributed through a dedicated system. The system ensures that every citizen receives the dividend.

Registration:

Citizens register for the dividend. The registration is simple. It can be done online or in person. The registration is verified against the national registry.

Payment:

The dividend is paid electronically. The payment is made to the citizen's bank account. If the citizen does not have a bank account, the payment is made through a prepaid card.

Frequency:

The dividend is paid monthly. The monthly payment provides regular income. It supports the circular flow of the economy.

Verification:

The distribution is verified annually. The verification ensures that every citizen receives the dividend. The verification also ensures that no one receives the dividend fraudulently.

E.4 The Funding Sources – Detailed Specification

E.4.1 AI Royalties

Definition: An AI royalty is a payment made by companies that deploy AI. The royalty is a percentage of AI-generated revenue.

Rate: 1% of AI-generated revenue. The rate is specified in the Productivity Dividend Act. It can be changed by subsequent legislation.

Base: AI-generated revenue is defined as revenue from products and services that use AI. The definition is specified in the Act.

Collection: The royalty is collected by the tax authority. The tax authority audits the companies to ensure compliance.

Use: The royalty revenue is deposited into the Productivity Dividend Fund. The revenue is used to pay the dividend.

Example: A company generates $100 million in AI-generated revenue. The AI royalty is $1 million. The $1 million is deposited into the Fund.

E.4.2 Productivity Taxes

Definition: A productivity tax is a tax on productivity gains. The tax is paid by companies that benefit from productivity growth.

Rate: 5% of productivity-attributable GDP growth. The rate is specified in the Productivity Dividend Act. It can be changed by subsequent legislation.

Base: The tax base is the productivity-attributable GDP growth. The base is calculated using the NPI. The formula is specified in the Act.

Collection: The tax is collected by the tax authority. The tax authority audits the companies to ensure compliance.

Use: The tax revenue is deposited into the Productivity Dividend Fund. The revenue is used to pay the dividend.

Example: The NPI grows by 2%. GDP is $250 billion. The productivity-attributable GDP growth is $5 billion. The productivity tax is $250 million. The $250 million is deposited into the Fund.

E.4.3 Sovereign AI Equity

Definition: Sovereign AI equity is equity owned by the government in AI companies. The dividends from the equity fund the dividend.

Acquisition: The government acquires equity through investment. The government also acquires equity through public ownership of AI infrastructure.

Management: The equity is managed by a sovereign wealth fund. The fund is managed independently. The fund is accountable to the public.

Dividends: The dividends from the equity are deposited into the Productivity Dividend Fund. The dividends are used to pay the dividend.

Example: The government owns 5% of an AI company. The company pays a dividend of $10 million. The government's share is $500,000. The $500,000 is deposited into the Fund.

E.4.4 Resource Efficiency Levies

Definition: A resource efficiency levy is a payment made by companies that benefit from resource savings. The levy is a share of the resource savings.

Rate: The rate is specified in the Productivity Dividend Act. The default rate is a share of the resource savings.

Base: The levy base is the resource savings. The savings are calculated using the NPI. The formula is specified in the Act.

Collection: The levy is collected by the environmental agency. The agency audits the companies to ensure compliance.

Use: The levy revenue is deposited into the Productivity Dividend Fund. The revenue is used to pay the dividend.

Example: A company reduces its energy consumption by 10%. The energy savings are $1 million. The resource efficiency levy is $100,000. The $100,000 is deposited into the Fund.

E.5 The Distribution Mechanism – Detailed Specification

E.5.1 Eligibility

Who is eligible? Every citizen of Asteria is eligible. Citizenship is defined in the Asteria Citizenship Act.

When does eligibility begin? Eligibility begins at birth. The citizen must be registered in the national registry.

When does eligibility end? Eligibility ends at death. The estate does not receive the dividend.

Are there any exclusions? There are no exclusions. The dividend is universal and unconditional.

E.5.2 Registration

How does a citizen register? The citizen registers through the national registry. The registration is automatic for newborns. The registration is required for immigrants.

What information is required? The citizen's name, address, and bank account details. The citizen's national identification number.

How is the registration verified? The registration is verified against the national registry. The verification ensures that the citizen is eligible.

E.5.3 Payment

How is the payment made? The payment is made electronically. The payment is made to the citizen's bank account.

What if the citizen does not have a bank account? The payment is made through a prepaid card. The card is provided by the government.

What is the payment frequency? The payment is made monthly. The payment is made on the first day of the month.

What is the payment amount? The payment amount is determined annually. The amount is based on the revenue from productivity-linked sources.

What happens if the citizen moves? The citizen updates their address in the national registry. The payment is made to the new address.

E.5.4 Verification

How is the distribution verified? The distribution is verified annually. The verification ensures that every citizen receives the dividend.

How is fraud prevented? The registration is verified against the national registry. The payment is made to the citizen's bank account. The verification is audited annually.

What happens if there is fraud? The fraudulent recipient is prosecuted. The fraudulent payment is recovered.

E.6 The Governance Framework – Detailed Specification

E.6.1 The Productivity Dividend Board – Composition

Member	Appointment	Term
Chair	President of Asteria	5 years
Ministry of Finance	Minister of Finance	Ex officio
Statistical Agency	Director of Statistical Agency	Ex officio
Central Bank	Governor of Central Bank	Ex officio
Independent Economist	Appointed by the Board	5 years
Social Policy Expert	Appointed by the Board	5 years
Citizen Representative	Appointed by the Board	5 years

E.6.2 The Productivity Dividend Board – Responsibilities

Funding Oversight:

- Oversee the collection of productivity-linked revenue
- Ensure that the revenue is collected efficiently and fairly
- Audit the revenue collection

Dividend Determination:

- Calculate the dividend amount annually
- Apply the formula specified in the Act
- Publish the dividend amount

Distribution Oversight:

- Oversee the distribution of the dividend
- Ensure that every eligible citizen receives the dividend
- Audit the distribution

Reporting:

- Publish an annual report
- Include the revenue, dividend, and distribution in the report
- Make the report available to the public

Advising:

- Advise the government on productivity policy
- Recommend changes to the funding mechanism
- Recommend changes to the dividend formula

E.6.3 The Productivity Dividend Fund – Governance

Fund Management:

- The Fund is managed by an independent board
- The board is appointed by the Productivity Dividend Board
- The board is accountable to the public

Fund Accounting:

- The Fund's accounts are publicly available
- The accounts are audited annually
- The audit report is published annually

Investment Policy:

- The Fund's reserves are invested
- The investment policy is prudent
- The investments are diversified
- The investments are low-risk

E.7 The Implementation Roadmap

E.7.1 Phase 1: Legal Establishment (Years 1–2)

Activities:

1. Draft the Productivity Dividend Act
2. Establish the Productivity Dividend Board
3. Establish the Productivity Dividend Fund
4. Define the funding sources
5. Define the distribution mechanism

Milestones:

1. The Act is passed (Year 1)
2. The Board is appointed (Year 1)
3. The Fund is established (Year 2)
4. The distribution system is designed (Year 2)

E.7.2 Phase 2: Pilot Implementation (Years 3–5)

Activities:

1. Test the funding mechanism
2. Test the distribution mechanism
3. Test the governance framework
4. Evaluate the pilot

Milestones:

1. The pilot is launched (Year 3)
2. The pilot is evaluated (Year 4)
3. The pilot is refined (Year 5)

E.7.3 Phase 3: Full Implementation (Years 6–10)

Activities:

1. Roll out the dividend nationally
2. Expand the funding sources
3. Optimise the distribution mechanism
4. Strengthen the governance framework

Milestones:

1. The dividend is distributed nationally (Year 6)
2. The funding sources are expanded (Year 7)
3. The distribution mechanism is optimised (Year 8)
4. The governance is strengthened (Year 10)

E.7.4 Phase 4: Maturity (Years 11+)

Activities:

1. Maintain the dividend
2. Adapt to changing circumstances
3. Continuously improve the program

Milestones:

1. The dividend is maintained (Ongoing)
2. The program is adapted (Ongoing)
3. The program is improved (Ongoing)

E.8 The Model Legislation

E.8.1 The Productivity Dividend Act (Model Text)

Republic of Asteria Productivity Dividend Act

Section 1: Establishment

1.1 The Productivity Dividend is established as a permanent program.
1.2 The dividend is funded from productivity-linked revenue sources.
1.3 The dividend is distributed to every citizen of Asteria.

Section 2: Eligibility

2.1 Every citizen of Asteria is eligible for the dividend.
2.2 The dividend is universal and unconditional.
2.3 There are no means tests or work requirements.

Section 3: Amount

3.1 The amount of the dividend is determined annually.
3.2 The amount is based on the revenue from productivity-linked sources.
3.3 The formula is: $D(t) = \tau \times \text{Revenue\_Productivity}(t) / \text{Population}(t)$

Section 4: Funding

4.1 The dividend is funded from productivity-linked revenue sources.
4.2 The sources include:
a) AI royalties
b) Productivity taxes
c) Sovereign AI equity dividends
d) Resource efficiency levies

Section 5: Distribution

5.1 The dividend is paid monthly.
5.2 The payment is made electronically.
5.3 The payment is made to the citizen's bank account.

Section 6: Governance

6.1 The Productivity Dividend Board oversees the dividend.
6.2 The Board is independent of the government.
6.3 The Board is accountable to the public.

Section 7: Accountability

7.1 The dividend is subject to annual audit.
7.2 The audit is conducted by an independent auditor.
7.3 The audit report is published annually.

Section 8: Effective Date

8.1 This Act takes effect on 1 January 2026.

E.9 The Economic Impact – Simulation Results

E.9.1 Impact on Inequality

Metric	Before Dividend	After Dividend	Change
Gini Coefficient	0.35	0.31	-11.4%
Poverty Rate	10.0%	6.5%	-35.0%
Bottom 20% Income Share	5.0%	7.5%	50.0%

The dividend significantly reduces inequality.

E.9.2 Impact on the Circular Flow

Metric	Before Dividend	After Dividend	Change
Consumption	$200 billion	$210 billion	5.0%
GDP	$250 billion	$257.5 billion	3.0%
Employment	95%	96%	1.0%

The dividend supports the circular flow.

E.9.3 Impact on Poverty

Demographic	Poverty Rate Before	Poverty Rate After	Change
All Citizens	10.0%	6.5%	-35.0%
Children	12.0%	7.5%	-37.5%
Elderly	8.0%	5.0%	-37.5%
Single Parents	20.0%	12.0%	-40.0%

The dividend reduces poverty across all demographics.

E.10 Conclusion

The Productivity Dividend is a practical, implementable, and beneficial program. It shares the gains of productivity broadly. It reduces inequality and poverty. It supports the circular flow of the economy.

The legal framework is established by the Productivity Dividend Act. The Act sets out the eligibility, the amount, the funding, the distribution, the governance, and the accountability.

The institutional framework includes the Productivity Dividend Board, the Productivity Dividend Fund, and the distribution system. The Board oversees the program. The Fund holds the revenue. The system distributes the dividend.

The funding sources include AI royalties, productivity taxes, sovereign AI equity, and resource efficiency levies. The funding is sustainable and equitable.

The implementation roadmap is phased. The program is established, piloted, rolled out, and matured. The implementation is gradual and managed.

The Productivity Dividend is a cornerstone of the Productivity Economy. It is the mechanism for sharing the gains of productivity. It is the foundation of a more equitable and stable society.

Appendix F: Policy Implementation – Legislative Framework and Transition Path

A comprehensive guide to the legislative, regulatory, and institutional changes required to implement the Productivity Economy.

F.1 Overview

The transition to the Productivity Economy requires a comprehensive policy framework. It requires changes in legislation, regulation, and institutions. It requires a phased implementation that manages the transition smoothly.

This appendix provides a detailed policy framework for implementing the Productivity Economy. It covers the legislative framework, the regulatory framework, the institutional framework, and the transition path.

The policy framework is comprehensive. It covers all aspects of the transition: the NPI, the Productivity Bond, the Productivity Dividend, and the governance.

The policy framework is phased. It is implemented in stages. The stages are designed to manage the transition smoothly.

The policy framework is practical. It is based on existing institutions and practices. It does not require a revolution. It requires evolution.

F.2 The Legislative Framework

F.2.1 The NPI Act

Purpose: To establish the National Productivity Index (NPI) as a legal measure of productivity.

Key Provisions:

1. Definition of the NPI: The NPI is defined as:

$$NPI(t) = GDP(t)/[H(t)^{0}.40 \times E(t)^{0}.25 \times M(t)^{0}.20 \times K(t)^{0}.15]$$

2. Measurement: The NPI is measured by the national statistical agency. The methodology is specified in the Act.
3. Publication: The NPI is published quarterly. The publication schedule is specified in the Act.
4. Finality: The NPI is final for payment purposes after 12 months. Revisions do not affect past payments.
5. Governance: The NPI Board oversees the NPI. The Board is independent. The Board is accountable to the public.
6. Audit: The NPI is audited annually. The audit is conducted by an independent auditor.

F.2.2 The Productivity Bond Act

Purpose: To authorise the issuance of Productivity Bonds and establish the legal framework for the instrument.

Key Provisions:

1. Authorisation: The government is authorised to issue Productivity Bonds. The issuance is subject to the limits specified in the Act.
2. Terms: The terms of the Productivity Bond are specified in the Act. The terms include the coupon formula, the floor, the cap, and the maturity.
3. Coupon Formula: The coupon formula is:

$$c(t) = (1 + \pi(t)) \times (1 + min[max(\alpha \times g_N PI(t), F), C]) - 1$$

4. Issuance: The Productivity Bonds are issued through a competitive auction. The auction process is specified in the Act.

5. Governance: The Debt Management Office manages the issuance. The Office is accountable to the Ministry of Finance.

6. Reporting: The government reports on the Productivity Bonds annually. The report includes the issuance, the performance, and the benefits.

F.2.3 The Productivity Dividend Act

Purpose: To establish the Productivity Dividend and set out the legal framework for the program.

Key Provisions:

1. Establishment: The Productivity Dividend is established as a permanent program. It is funded from productivity-linked revenue sources. It is distributed to every citizen.

2. Eligibility: Every citizen is eligible for the dividend. The dividend is universal and unconditional. There are no means tests or work requirements.

3. Amount: The amount of the dividend is determined annually. The amount is based on the revenue from productivity-linked sources. The formula is specified in the Act.

4. Funding: The dividend is funded from productivity-linked revenue sources. The sources include AI royalties, productivity taxes, sovereign AI equity, and resource efficiency levies.

5. Distribution: The dividend is paid monthly. The payment is made electronically. The payment is made to the citizen's bank account.

6. Governance: The Productivity Dividend Board oversees the dividend. The Board is independent. The Board is accountable to the public.

F.2.4 The Fiscal Responsibility Act (Amended)

Purpose: To amend the Fiscal Responsibility Act to include the Productivity Bond and the Productivity Dividend in the fiscal framework.

Key Provisions:

1. Debt Framework: The Productivity Bond is included in the debt framework. The debt targets are specified. The reporting requirements are specified.

2. Fiscal Targets: The fiscal targets are amended to reflect the Productivity Bond. The targets include the debt-to-GDP ratio, the primary balance, and the interest burden.

3. Risk Management: The fiscal risk management framework is amended to include the Productivity Bond. The risk assessment includes the productivity risk. The risk mitigation includes the floor and cap.

4. Reporting: The fiscal reporting is amended to include the Productivity Bond and the Productivity Dividend. The reports include the performance, the benefits, and the risks.

F.3 The Regulatory Framework

F.3.1 The Financial Market Regulation

Purpose: To regulate the market for Productivity Bonds and ensure the integrity of the instrument.

Key Provisions:

1. Issuance: The Productivity Bonds are issued through a regulated auction. The auction is conducted by the Debt Management Office. The auction is transparent and competitive.

2. Trading: The Productivity Bonds are traded on a regulated exchange. The exchange ensures liquidity and price discovery. The exchange ensures fair trading.

3. Disclosure: The issuers disclose all material information. The disclosure includes the NPI, the coupon, and the performance. The disclosure is timely and accurate.

4. Investor Protection: Investors are protected by the regulatory framework. The framework ensures fair treatment. The framework ensures transparency. The framework ensures accountability.

F.3.2 The Statistical Regulation

Purpose: To regulate the measurement of the NPI and ensure the integrity of the data.

Key Provisions:

1. Data Quality: The statistical agency ensures the quality of the data. The data is accurate, timely, and complete. The data is subject to quality control.

2. Methodology: The methodology for the NPI is specified in the regulation. The methodology is transparent. The methodology is publicly available.

3. Independence: The statistical agency is independent. It is not subject to political interference. It is accountable to the public.

4. Audit: The NPI is audited annually. The audit is conducted by an independent auditor. The audit ensures the accuracy and reliability of the data.

F.3.3 The Tax Regulation

Purpose: To regulate the tax treatment of the Productivity Bond and the Productivity Dividend.

Key Provisions:

1. Tax Exemption: The Productivity Bond is tax-exempt for domestic investors. The coupons are not subject to income tax. The principal is not subject to capital gains tax.

2. Taxation of the Dividend: The Productivity Dividend is tax-exempt. The dividend is not subject to income tax. The dividend is not subject to other taxes.

3. Taxation of Productivity-Linked Revenue: The productivity-linked revenue is taxed at a preferential rate. The rate is specified in the regulation. The rate is designed to encourage productivity.

F.4 The Institutional Framework

F.4.1 The NPI Board

Feature	Specification
Purpose	To oversee the NPI methodology
Composition	7 members (Chair, statistical agency, finance ministry, debt management, independent economist, independent statistician, investor representative)
Responsibilities	Approving methodology, reviewing methodology, resolving disputes, publishing annual report
Independence	Independent of the government
Accountability	Accountable to the public

F.4.2 The Productivity Dividend Board

Feature	Specification
Purpose	To oversee the Productivity Dividend
Composition	7 members (Chair, finance ministry, statistical agency, central bank, independent economist, social policy expert, citizen representative)
Responsibilities	Overseeing funding, determining dividend, overseeing distribution, publishing annual report, advising government
Independence	Independent of the government
Accountabilit	Accountable to the public

F.4.3 The Productivity Dividend Fund

Feature	Specification
Purpose	To hold productivity-linked revenue and pay the dividend
Structure	Dedicated fund, separate from the budget
Revenue	AI royalties, productivity taxes, sovereign AI equity, resource efficiency levies
Expenditure	Productivity Dividend payments
Reserves	Held to smooth the dividend over time
Governance	Independent board, transparent accounting, prudent investment

F.4.4 The Debt Management Office

Feature	Specification
Purpose	To manage the government's debt portfolio
Responsibilities	Issuing the Productivity Bond, managing the portfolio, reporting on performance
Reporting	Accountable to the Ministry of Finance
Expertise	Professional debt management, risk management, market engagement

F.5 The Transition Path – Detailed

F.5.1 Phase 1: Preparation (Years 1–2)

Activity	Timeline	Responsibility
Draft the NPI Act	Year 1	Ministry of Finance
Establish the NPI Board	Year 1	President of Asteria
Draft the Productivity Bond Act	Year 1	Ministry of Finance
Draft the Productivity Dividend Act	Year 1	Ministry of Social Affairs
Amend the Fiscal Responsibility Act	Year 1	Ministry of Finance
Establish the statistical capacity	Year 2	Statistical Agency
Design the market infrastructure	Year 2	Debt Management Office
Engage with investors	Year 2	Debt Management Office

Milestones:

- NPI Act passed (Year 1, Q4)
- NPI Board appointed (Year 1, Q4)

- Productivity Bond Act passed (Year 2, Q2)
- Productivity Dividend Act passed (Year 2, Q2)
- Statistical capacity established (Year 2, Q4)

F.5.2 Phase 2: Pilot (Years 3–5)

Activity	Timeline	Responsibility
Issue the first Productivity Bond	Year 3	Debt Management Office
Monitor the performance	Years 3–5	Debt Management Office
Test the NPI measurement	Years 3–5	Statistical Agency
Pilot the Productivity Dividend	Years 4–5	Productivity Dividend Board
Evaluate the pilot	Year 5	Independent evaluator
Refine the design	Year 5	Ministry of Finance

Milestones:

- First Productivity Bond issued (Year 3, Q2)
- Productivity Dividend pilot launched (Year 4, Q1)
- Pilot evaluation completed (Year 5, Q4)

F.5.3 Phase 3: Expansion (Years 6–15)

Activity	Timeline	Responsibility
Increase Productivity Bond issuance	Years 6–15	Debt Management Office
Extend the maturity	Years 6–15	Debt Management Office
Expand the investor base	Years 6–15	Debt Management Office
Develop the secondary market	Years 6–15	Financial Regulatory Authority
Roll out the Productivity Dividend	Years 6–10	Productivity Dividend Board
Expand the funding sources	Years 6–15	Ministry of Finance

Milestones:

- Productivity Bond share reaches 10% (Year 10)
- Productivity Dividend rolled out nationally (Year 8)
- Secondary market developed (Year 10)

F.5.4 Phase 4: Integration (Years 16–25)

Activity	Timeline	Responsibility
Optimise the debt portfolio	Years 16–25	Debt Management Office
Achieve critical mass	Years 16–25	Debt Management Office
Integrate the Productivity Dividend	Years 16–25	Productivity Dividend Board
Build the international framework	Years 16–25	Ministry of Finance
Strengthen the governance	Years 16–25	All institutions

Milestones:

- Productivity Bond share reaches 30% (Year 20)
- Productivity Dividend fully integrated (Year 20)
- International framework established (Year 25)

F.5.5 Phase 5: Transformation (Years 26+)

Activity	Timeline	Responsibility
Complete the transition	Years 26+	All institutions
Achieve the benefits	Years 26+	All institutions
Build the global architecture	Years 26+	Ministry of Finance
Secure the future	Years 26+	All institutions

Milestones:

- Productivity Bond share reaches 50% (Year 30)
- Productivity Economy achieved (Year 30+)
- Global architecture established (Year 35)

F.6 The Legislative Timeline

Year	Legislation	Status
1	NPI Act	Drafted, passed
1	Productivity Bond Act	Drafted, passed
1	Productivity Dividend Act	Drafted, passed
1	Fiscal Responsibility Act (Amended)	Drafted, passed
2	Financial Market Regulation	Drafted, implemented
2	Statistical Regulation	Drafted, implemented
2	Tax Regulation	Drafted, implemented
5	Evaluation and Amendment	Review, amend
10	Evaluation and Amendment	Review, amend
15	Evaluation and Amendment	Review, amend
20	Evaluation and Amendment	Review, amend
25	Evaluation and Amendment	Review, amend

F.7 The Institutional Timeline

Year	Institution	Status
1	NPI Board	Established
1	Productivity Dividend Board	Established
1	Productivity Dividend Fund	Established
2	Statistical Capacity	Strengthened
2	Debt Management Office	Strengthened
3	Market Infrastructure	Developed
5	Evaluation	Conducted
10	Evaluation	Conducted
15	Evaluation	Conducted
20	Evaluation	Conducted
25	Evaluation	Conducted

F.8 The Risk Management Framework

F.8.1 Risk Identification

Risk	Description	Probability	Impact
Political Risk	Government interferes with NPI	Low	High
Measurement Risk	NPI measurement error	Medium	Medium
Investor Risk	Investors reject the bond	Low	High
Liquidity Risk	Secondary market illiquid	Medium	Medium
Transition Risk	Transition is mismanaged	Medium	High

F.8.2 Risk Mitigation

Risk	Mitigation
Political Risk	Independent NPI Board, legal lock on methodology
Measurement Risk	Strong statistical capacity, independent audit
Investor Risk	Investor engagement, demonstration of benefits
Liquidity Risk	Market making, development of secondary market
Transition Risk	Phased implementation, careful management

F.8.3 Risk Monitoring

Risk	Monitoring	Frequency
Political Risk	NPI Board reports	Annual
Measurement Risk	Audit reports	Annual
Investor Risk	Market feedback	Quarterly
Liquidity Risk	Market data	Monthly
Transition Risk	Implementation reviews	Quarterly

F.9 Communication and Stakeholder Engagement

F.9.1 Stakeholder Engagement

Stakeholder	Engagement	Frequency
Investors	Roadshows, briefings	Regular
Citizens	Public information, consultations	Regular
Media	Press releases, briefings	Regular
Parliament	Reports, briefings	Annual
International	Presentations, conferences	Regular

F.9.2 Key Messages

1. The Productivity Bond is a practical instrument. It reduces fiscal risk. It lowers costs. It improves stability.
2. The Productivity Dividend shares the gains. It reduces inequality. It supports the circular flow. It builds a more equitable society.
3. The Productivity Economy is the future. It is stable, sustainable, and equitable. It works within the limits of the planet.
4. The transition is managed. It is phased. It is gradual. It is designed to succeed.

F.9.3 Communication Channels

- Website: ProductiveAsteria.gov
- Social media: Twitter, LinkedIn
- Press: Press releases, briefings
- Reports: Annual reports, quarterly updates
- Events: Conferences, roadshows

F.10 Conclusion

The policy framework for the Productivity Economy is comprehensive, phased, and practical. It provides the legislative, regulatory, and institutional foundation for the transition.

The legislative framework includes the NPI Act, the Productivity Bond Act, the Productivity Dividend Act, and the Fiscal Responsibility Act. These Acts establish the legal foundation for the Productivity Economy.

The regulatory framework includes the financial market regulation, the statistical regulation, and the tax regulation. These regulations ensure the integrity of the instrument.

The institutional framework includes the NPI Board, the Productivity Dividend Board, the Productivity Dividend Fund, and the Debt Management Office. These institutions provide the governance for the Productivity Economy.

The transition path is phased. It includes preparation, pilot, expansion, integration, and transformation. The transition is managed and gradual.

The policy framework is the roadmap for the Productivity Economy. It provides the foundation for a stable, sustainable, and equitable future.

Appendix G: Investor Materials – Marketing and Disclosure Documents

A comprehensive suite of documents for marketing, explaining, and disclosing the Productivity Bond to investors.

G.1 Overview

This appendix provides a complete suite of investor materials for the Productivity Bond. These materials are designed to inform, educate, and persuade investors. They cover the key features of the bond, the risks, the benefits, and the practical details.

The materials are comprehensive. They include a summary, a detailed presentation, a frequently asked questions document, a risk disclosure, a performance simulation, and a glossary.

The materials are clear. They are written in plain language. They avoid jargon. They explain complex concepts simply.

The materials are transparent. They disclose all material information. They are honest about the risks. They are honest about the uncertainties.

G.2 Executive Summary

G.2.1 The Productivity Bond at a Glance

Feature	Description
Name	Asteria Productivity Bond 2026–2036
Issuer	Republic of Asteria
Principal	ASD 1,000 per bond
Total Issuance	ASD 1,000,000,000
Maturity	10 years
Coupon	Variable: linked to productivity and inflation
Inflation Protection	Full inflation protection (CPI)
Productivity Linkage	70% participation in NPI growth
Real Return Floor	0%
Real Return Cap	5%
Payment Frequency	Annual
Currency	Asterian Dollar (ASD)
Credit Rating	AA (S&P), Aa2 (Moody's)

G.2.2 Key Benefits

For Investors:

1. Inflation Protection: The coupon is linked to CPI. Your purchasing power is protected.
2. Productivity Participation: You participate in the productivity of the economy. You benefit when productivity rises.
3. Downside Protection: The real return is floored at 0%. You cannot lose purchasing power.
4. Diversification: The Productivity Bond is different from conventional bonds. It provides diversification benefits.
5. Counter cyclicality: The coupon is higher in good times and lower in bad times. The bond is resilient.

For the Government:

1. Countercyclical Financing: The coupon is lower in bad times. The government saves money when it needs it most.
2. Risk Sharing: The government shares the risks of the economy with investors. The fiscal position is more stable.
3. Incentives: The bond creates incentives for productivity. The government is encouraged to pursue productivity-enhancing policies.
4. Credibility: The bond signals that the government is committed to productivity. It builds credibility with investors.
5. Stability: The bond reduces the risk of fiscal crises. It stabilises the government's finances.

G.2.3 Key Risks

1. Productivity Risk: The NPI may not grow as expected. If productivity is low, the coupon may be low.
2. Measurement Risk: The NPI may be subject to measurement error. The coupon may be affected.
3. Inflation Risk: The coupon is linked to inflation. If inflation is lower than expected, the coupon may be lower.
4. Liquidity Risk: The Productivity Bond is a new instrument. The secondary market may be limited.
5. Political Risk: The NPI methodology may be subject to political interference. The government has established independent governance to prevent interference.

G.3 Investor Presentation

G.3.1 Slide 1: Title

The Asteria Productivity Bond

A New Instrument for a New Economy

G.3.2 Slide 2: The Problem

The Infinite Debt Problem

- Global debt exceeds $300 trillion
- Debt compounds automatically, regardless of economic performance
- The financial system requires perpetual growth
- The planet cannot support perpetual growth

The Result:

- Increasing fiscal instability
- More frequent and severe crises
- Growing inequality
- Environmental destruction

G.3.3 Slide 3: The Solution

The Productivity Bond

A sovereign debt instrument whose return is linked to measurable improvements in productivity.

Key Features:

- Inflation protection
- Productivity participation

- Downside protection (0% floor)
- Upside limit (5% cap)
- Countercyclical payments

The Result:

- More stable fiscal position
- Reduced risk of crises
- Aligned with long-term prosperity
- Sustainable and equitable

G.3.4 Slide 4: How It Works

The Coupon Formula:

$$c(t) = (1 + \pi(t)) \times (1 + min[max(0.7 \times g_N PI(t), 0\%), 5\%]) - 1$$

In Words:

- You receive full inflation protection
- You receive 70% of any productivity growth
- Your real return cannot fall below 0%
- Your real return cannot exceed 5%

G.3.5 Slide 5: The National Productivity Index

Definition:

$$NPI(t) = GDP(t) / [H(t)^{0}.40 \times E(t)^{0}.25 \times M(t)^{0}.20 \times K(t)^{0}.15]$$

Components:

- Labour productivity (40%)
- Energy productivity (25%)
- Material productivity (20%)
- Capital productivity (15%)

Why It Matters:

- Measures the efficiency of the economy
- Transparent and auditable
- Resistant to manipulation
- Aligned with long-term prosperity

G.3.6 Slide 6: The Performance Simulation Results

Metric	Conventional Bond	Productivity Bond	Improvement
Expected Cost	0.4521	0.4056	-10.3%
Distress Probability	18.32%	14.21%	-22.4%
Welfare	0.8954	0.7889	-11.9%

The Productivity Bond:

- Reduces expected financing costs
- Reduces probability of fiscal distress
- Improves government welfare

G.3.7 Slide 7: The Investor Return

Expected Real Return:

Scenario	NPI Growth	Real Return	Nominal Return ($\pi = 2\%$)
Recession	-2%	0%	2%
Stagnation	0%	0%	2%
Normal	2%	1.4%	3.4%
Strong	4%	2.8%	4.8%
AI Boom	8%	5%	7%

The Bond Provides:

- Downside protection (0% real floor)
- Upside participation (capped at 5% real)
- Inflation protection
- Diversification benefits

G.3.8 Slide 8: The Pricing

Issue Price:

- Expected real return: 1.4%
- Risk premium: 0.5%
- Issue price: ~97.6% of par

Effective Yield:

- 3.48% nominal
- 1.48% real

Comparable:

1. Conventional 10-year bond: 4.0% nominal
2. Inflation-linked bond: 3.5% nominal
3. Productivity Bond: 3.48% nominal (plus productivity participation)

G.3.9 Slide 9: The Governance

Independent Governance:

- NPI Board: 7 independent members
- Statistical Agency: Independent, professional
- Audit: Annual independent audit

- Dispute Resolution: Binding arbitration

Key Protections:

- Methodology is locked for the bond's life
- NPI is final for payment purposes
- No government interference
- Full transparency

G.3.10 Slide 10: The Investment Case

Why Invest in the Productivity Bond?

- Inflation Protection: Preserve purchasing power
- Productivity Participation: Benefit from economic growth
- Downside Protection: 0% real floor
- Diversification: Different from conventional bonds
- Counter cyclicality: Resilient in bad times
- ESG Alignment: Supports productive, sustainable economy
- Sovereign Credit Quality: AA/Aa2 rated
- Transparency: Clear, auditable methodology

G.3.11 Slide 11: The Risks

Risk Mitigation:

Risk	Mitigation
Productivity Risk	Diversification, long-term perspective
Measurement Risk	Independent governance, audit
Inflation Risk	CPI linkage
Liquidity Risk	Market making, secondary market
Political Risk	Independent board, legal lock

Risk Disclosure: The Productivity Bond is a new instrument. The risks are different from conventional bonds. Investors should carefully consider their risk tolerance.

G.3.12 Slide 12: Next Steps

How to Invest:

1. Contact: Debt Management Office, Republic of Asteria
2. Read: The Prospectus (available online)
3. Bid: Competitive auction (details available)
4. Allocate: Bonds allocated to successful bidders
5. Settle: Settlement through the Central Bank

Timeline:

- Issue Date: 1 July 2026

- First Payment: 31 January 2027
- Maturity: 1 July 2036

G.4 Frequently Asked Questions (FAQ)

G.4.1 General Questions

Q: What is the Productivity Bond?

A: The Productivity Bond is a sovereign debt instrument whose return is linked to measurable improvements in productivity. It provides inflation protection and a real return based on the growth of the National Productivity Index (NPI).

Q: Who is the issuer?

A: The issuer is the Republic of Asteria, a stable, advanced economy with a AA/Aa2 credit rating.

Q: What is the total issuance?

A: ASD 1,000,000,000 (1 billion Asterian Dollars).

Q: What is the maturity?

A: 10 years.

G.4.2 Coupon Questions

Q: How is the coupon calculated?

A: The coupon is calculated using the formula:

$$c(t) = (1 + \pi(t)) \times (1 + min[max(0.7 \times g_N PI(t), 0\%), 5\%]) - 1$$

where π(t) is inflation and g_NPI(t) is the growth of the National Productivity Index.

Q: What is the inflation protection?

A: The coupon is linked to CPI. The nominal return is adjusted for inflation. Your purchasing power is protected.

Q: What is the productivity participation?

A: The real return is 70% of the growth of the NPI. You participate in the productivity of the economy.

Q: What is the floor?

A: The real return is floored at 0%. You cannot lose purchasing power.

Q: What is the cap?

A: The real return is capped at 5%. This protects the government from extreme outcomes.

G.4.3 NPI Questions

Q: What is the NPI?

A: The National Productivity Index (NPI) is a measure of the efficiency of the economy. It is defined as:

$$NPI(t) = GDP(t) / [H(t)^{0}.40 \times E(t)^{0}.25 \times M(t)^{0}.20 \times K(t)^{0}.15]$$

Q: What are the components of the NPI?

A: The NPI includes labour productivity (40%), energy productivity (25%), material productivity (20%), and capital productivity (15%).

Q: Who measures the NPI?

A: The NPI is measured by the independent Asteria Statistical Agency.

Q: Is the NPI subject to revision?

A: Yes, but for payment purposes, the NPI is final after 12 months. Revisions do not affect past coupons.

G.4.4 Risk Questions

Q: What are the risks of the Productivity Bond?

A: The risks include productivity risk (the NPI may not grow as expected), measurement risk (the NPI may be subject to measurement error), inflation risk (inflation may be lower than expected), liquidity risk (the secondary market may be limited), and political risk (the NPI methodology may be subject to political interference).

Q: How are the risks mitigated?

A: The risks are mitigated through independent governance, audit, legal lock, and market making.

Q: Is the Productivity Bond suitable for all investors?

A: No. The Productivity Bond is a new instrument. Investors should carefully consider their risk tolerance and investment objectives.

G.4.5 Investment Questions

Q: How can I invest in the Productivity Bond?

A: You can invest through the competitive auction. The auction details are available from the Debt Management Office.

Q: What is the minimum investment?

A: The minimum investment is ASD 1,000 (1 bond).

Q: What is the expected return?

A: The expected real return is 1.4%. The expected nominal return is 3.4% (assuming 2% inflation).

Q: Is the Productivity Bond tax-exempt?

A: Yes, for domestic investors. The coupons are not subject to income tax. The principal is not subject to capital gains tax.

G.4.6 Other Questions

Q: How is the Productivity Bond different from a conventional bond?

A: The Productivity Bond has a variable coupon linked to productivity. It provides inflation protection and downside protection. It is countercyclical.

Q: How is the Productivity Bond different from an inflation-linked bond?

A: The Productivity Bond provides productivity participation in addition to inflation protection. The real return is linked to productivity.

Q: How is the Productivity Bond different from a GDP-linked bond?

A: The Productivity Bond is linked to productivity, not GDP. Productivity measures efficiency. GDP measures growth.

Q: What happens at maturity?

A: The principal is repaid in full at maturity.

G.5 Risk Disclosure Document

G.5.1 General Risk Warning

The Productivity Bond is a new instrument. The risks are different from conventional bonds. Investors should carefully consider their risk tolerance and investment objectives before investing.

This document is not a recommendation to invest. It is a disclosure of the risks. Investors should consult their own financial advisors.

G.5.2 Productivity Risk

The coupon on the Productivity Bond is linked to the NPI. If the NPI does not grow as expected, the coupon may be low. If the NPI falls, the coupon may be floored at 0%.

Factors that may affect the NPI:

- Economic conditions
- Productivity-enhancing investments
- Technological innovation
- Resource availability
- Ecological constraints

The NPI may not grow as expected. Investors may receive lower returns than expected.

G.5.3 Measurement Risk

The NPI is measured by the Asteria Statistical Agency. The measurement is subject to error. The error may affect the coupon.

Sources of measurement error:

- Data quality issues
- Methodological limitations
- Seasonal adjustment errors
- Data revisions

The measurement error may be significant. Investors may receive different returns than expected.

G.5.4 Inflation Risk

The coupon is linked to inflation (CPI). If inflation is lower than expected, the nominal coupon may be lower. The real return may be lower.

Factors that may affect inflation:

- Monetary policy
- Economic conditions
- Supply shocks
- Demand shocks

Inflation may be lower than expected. Investors may receive lower nominal returns.

G.5.5 Liquidity Risk

The Productivity Bond is a new instrument. The secondary market may be limited. Investors may not be able to sell the Bonds easily.

Factors that may affect liquidity:

- Investor interest

- Market conditions
- Trading volume
- Bid-ask spread

The secondary market may be limited. Investors may not be able to sell the Bonds at the desired price.

G.5.6 Political Risk

The NPI methodology may be subject to political interference. The government has established independent governance to prevent interference.

Factors that may affect political risk:

- Government stability
- Political pressure
- Institutional strength
- Legal protection

The independent governance is designed to mitigate political risk. However, political risk cannot be entirely eliminated.

G.6 Performance Simulation

G.6.1 Scenario Analysis

Scenario	Probability	NPI Growth	Real Return	Nominal Return ($\pi = 2\%$)
Severe Recession	5%	-3%	0%	2.0%
Mild Recession	15%	-1%	0%	2.0%
Stagnation	20%	0%	0%	2.0%
Normal Growth	30%	2%	1.4%	3.4%
Strong Growth	20%	4%	2.8%	4.8%
AI Boom	10%	8%	5.0%	7.0%

- Expected Real Return: 1.4%
- Expected Nominal Return: 3.4%

G.6.2 Historical Backtest

Year	NPI Growth	Real Return	Nominal Return ($\pi = 2\%$)
2016	1.8%	1.3%	3.3%
2017	2.1%	1.5%	3.5%
2018	1.5%	1.1%	3.1%
2019	1.9%	1.3%	3.3%
2020	-1.2%	0%	2.0%
2021	3.2%	2.2%	4.2%
2022	2.5%	1.8%	3.8%
2023	1.6%	1.1%	3.1%
2024	2.0%	1.4%	3.4%

2025	2.3%	1.6%	3.6%

- Average Real Return: 1.3%
- Average Nominal Return: 3.3%

G.7 Glossary

Term	Definition
Cap	The maximum real return on the Productivity Bond. The cap is 5%.
CPI	Consumer Price Index. The measure of inflation used in the coupon formula.
Floor	The minimum real return on the Productivity Bond. The floor is 0%.
GDP	Gross Domestic Product. The measure of economic output used in the NPI.
NPI	National Productivity Index. The measure of productivity used in the coupon formula.
Productivity Bond	A sovereign debt instrument whose return is linked to productivity.
Productivity Dividend	A distribution of a portion of productivity gains to every citizen.
Real Return	The return after adjusting for inflation.
State-Contingent	An instrument whose payments depend on the state of the economy.

G.8 Contact Information

G.8.1 Debt Management Office

Address: Debt Management Office, Ministry of Finance, 1 Government Avenue, Asteria City, Asteria

Phone: +555-123-4567

Email: dmo@finance.gov.asteria

Website: www.dmo.gov.asteria

G.8.2 Asteria Statistical Agency

Address: Asteria Statistical Agency, 1 Statistical Plaza, Asteria City, Asteria

Phone: +555-123-4568

Email: asa@stats.asteria

Website: www.stats.asteria

G.8.3 Central Bank of Asteria

Address: Central Bank of Asteria, 1 Central Bank Square, Asteria City, Asteria

Phone: +555-123-4569

Email: cb@centralbank.asteria

Website: www.centralbank.asteria

G.9 Conclusion

The investor materials provide a comprehensive suite of documents for marketing, explaining, and disclosing the Productivity Bond. They are designed to inform, educate, and persuade investors.

The materials are comprehensive. They cover all aspects of the bond: the features, the risks, the benefits, and the practical details.

The materials are clear. They are written in plain language. They avoid jargon. They explain complex concepts simply.

The materials are transparent. They disclose all material information. They are honest about the risks. They are honest about the uncertainties.

The Productivity Bond is a new instrument. It requires careful explanation. It requires transparent disclosure. It requires ongoing communication.

The investor materials are the foundation of that communication. They are the first step in building investor confidence. They are the foundation of a successful issuance.

Appendix H: Simulation Code & License

The simulation code used to generate all results in Appendix C is available at:

https://github.com/traffictorch/productivity-bond-model

Repository Contents

The repository includes:

- A complete Python implementation of the simulation model
- All calibration parameters (including g0 = 0.36, cap = 0.04, auto_stab = -0.05)
- The full Monte Carlo engine (10,000 paths, 10-year horizon)
- Bond valuation for all five bond types
- Portfolio optimisation routines
- Sensitivity analysis scripts (θ, α, N, coupon cap)
- All simulation results from Appendix C (CSV format)
- Documentation and usage instructions

Key Features

The simulation implements the feedback loop between coupon payments and debt accumulation - a critical feature not present in simpler models. This allows the simulation to capture the dynamic interaction between variable coupons, debt service, and the debt stock, revealing the nuanced results presented in Appendix C.

Calibration

The code is calibrated to reproduce the results in Appendix C using:

- g0_over_y0 = 0.36 (spending-to-GDP ratio)
- cap = 0.04 (real return cap)
- auto_stab = -0.05 (automatic stabiliser coefficient)
- distress_threshold = 0.15 (15% of revenue)

Reproducibility

To reproduce the results:

```
git clone https://github.com/traffictorch/productivity-bond-model.git
cd productivity-bond-model
pip install -r requirements.txt
python run_simulation.py --paths 10000 --years 10
```

License Information

- Share - copy and redistribute the material in any medium or format

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- NonCommercial - You may not use the material for commercial purposes.
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Simulation Code

The simulation code used to generate the results in this book is available under the MIT License at:

https://traffictorch.github.io/productivity-bond-model/

https://github.com/traffictorch/productivity-bond-model

Readers are encouraged to fork, modify, and improve the model. The code is fully reproducible, and all results in Appendix C can be independently verified by running the simulation.

This book began with two lines on a graph - one climbing toward infinity, the other flattening against the limits of a finite world. And it began with an elephant. The one we've built the room around and forgotten is even there.

That elephant is the assumption that tomorrow must always be larger than today. We've treated it like gravity - a law of nature, not a choice. But it is a choice. It always has been. Our ancestors knew it. They built Jubilees and debt forgiveness into the fabric of their societies because they understood that debt is a human invention, not a force of nature. We forgot that. We built a financial system that demands endless growth from a planet that cannot provide it, and we called it progress.

But here's the thing about elephants: they're hard to ignore once you've seen them. And once you've seen this one - once you've stared at those two lines and felt the gap between them - you can't unsee it. You can't pretend the contradiction isn't there.

The good news is that we don't need to tear the room down. We just need to move the elephant. We need to replace the mechanism of compound growth with the mechanism of productive prosperity. We need to build a financial system that rewards efficiency, innovation, and fairness - not extraction, expansion, and inequality. We need to remember that the purpose of the economy is to serve the community, not the other way around.

The tools are in our hands. The Productivity Bond is one of them. The Productivity Dividend is another. The roadmap is laid out. The simulation shows it works. The only question that remains is the one that has always been there, quietly waiting for us to ask it:

What do we actually want?

Do we want more stuff, or do we want a better life? Do we want infinite growth, or do we want prosperous stability? Do we want to keep building the room around the elephant, or do we finally want to move it?

The choice is ours. The future is not written. It is built - by the decisions we make today, the institutions we shape, and the world we choose to leave for those who come after us.

The infinite debt problem is not an inevitability. It is an invitation.

And I don't know about you, but I've never been one to ignore an invitation - especially when it comes with a chance to build something ePic.