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• NOBEL PRIZE IN CHEMISTRY

Mirror-image molecules and the chemistry of life

Some molecules exist in two forms, but life's building blocks use only one. Soai and Kagan showed how to make just that form in labs — crucial for medicines



AMITABH SINHA

CERTAIN MOLECULES exist in two forms, each a non-superimposable mirror image of the other — like the left and right hands of human beings. Chemically, the two forms are the same in the sense that they are composed of the same set of atoms, connected in the same order. The difference is only in the relative three-dimensional arrangement of those atoms, such that one happens to be the mirror image of the other.

This structural asymmetry, called chirality, becomes particularly interesting in biology. Many of the fundamental molecules in biology, like the amino acids that make up proteins or the sugars in DNA, appear in only one form. The mirror image versions of these amino acids or the sugars do exist, but they are rarely used in these biological settings. This preference for homochirality in life forms has intrigued scientists for long.

This year's Nobel Prize in Chemistry has been awarded to two scientists, Henry Kagan and Kenso Soai, for demonstrating how this homochirality can emerge.

The normal chemical processes used to produce a chiral molecule results in the production of both forms, called enantiomers. Kagan developed a way of manipulating these processes in such a manner that one form was produced in much greater proportion than the other. Soai took a step further and designed the first chemical reaction in which only one of the enantiomers was produced. Outside of biological processes, such a result had never been achieved.

The first breakthrough

The propensity of biochemistry to prefer one particular enantiomer over the other was initially thought to be something unique for life forms. After all, when chiral

• 'FOR THE DISCOVERY OF NON-LINEAR EFFECTS AND AUTOCATALYSIS IN ASYMMETRIC ORGANIC SYNTHESIS'



"Like hands, all amino acids exist as two mirrored variants, but only one of them is found in the proteins in your cells. The other is rarely found in nature."



HENRI B. KAGAN, 96
Professor Emeritus
at then Université
Paris-Sud, France



KENSO SOAI, 76
Professor Emeritus
at Tokyo University
of Science, Japan

WHEN MIRROR-IMAGE MOLECULES HARMED BABIES

A DRUG FOR MORNING SICKNESS

SICKNESS: Thalidomide was introduced in the late 1950s and marketed by a West German pharma company as a sedative. It was widely prescribed, including to pregnant women for morning sickness.



BIRTH DEFECTS: By 1961, doctors had linked the drug to severe birth defects. Thousands of babies across 46 countries were affected, many with phocomelia, in which limbs are severely shortened or absent.

THE MIRROR-IMAGE PROBLEM: Thalidomide exists as two mirror-image molecules, or enantiomers. One caused birth defects while the other produced the desired effects. Later, it was found the two forms can interconvert (change into each other) in the body.

ON THURSDAY: NOBEL PRIZE IN LITERATURE

Some key terms

Chirality: The phenomenon of molecules existing in mirror-image forms — much like your left and right hands.

Homochirality: The preference for one mirror-image form of a molecule in life forms.

linear relationship between the catalyst's chirality and the proportion in which the two forms of the product were produced. In other words, if the catalyst itself contained a disproportionate amount of one form, this would get reflected in the proportions of the final product as well.

Kagan was able to show that this was not true, and that much greater asymmetry in production could be achieved even if the catalyst was only mildly chiral. In the process he was also able to demonstrate the internal dynamics of how this was happening.

The next step

This breakthrough created a new excitement in the field. While studying one of the chemical reactions that had produced one particular enantiomer in large quantities, Soai realised that there were significant similarities in the catalyst used and the final product. That prompted him to explore autocatalytic reactions — chemical reactions in which the final products them-

selves act as catalysts.

None of the autocatalytic reactions known at the time Soai started experimenting with them in the 1990s were known to produce asymmetric formation of enantiomers. After about a decade of trying, he finally succeeded in carrying out an autocatalytic reaction that resulted in the production of one particular enantiomer, which then formed copies of itself in a self-replicating process. The final product contained 99.5% of one enantiomer, a result comparable to the kind of preference seen in biological processes for a particular version of a chiral molecule.

Mysteries of life

The work of Kagan and Soai has demonstrated that homochirality can be obtained in the laboratory as well. It was not exclusive to nature. Their work does not solve the origin of the puzzle of life — how biological processes themselves preferred homochirality. But it did open up fresh avenues for scientists to try and understand the chemistry of life.

Possibly the biggest practical implication of their work has been in the pharmaceutical industry. Many drug molecules are chiral, and it matters immensely which particular enantiomer has to be used.

This is because the human bodies prefer only those enantiomers. The other variety of molecule might not just be ineffective, they can even be harmful.

Before this Nobel Prize-winning work showed how one single enantiomer could be produced, pharma companies had been manufacturing the drug molecules as a mixture of both enantiomers, and then the desirable enantiomer was separated through a separate process. This was an expensive, wasteful and often technically difficult way of achieving the final result.

The asymmetric synthesis of a particular enantiomer, as shown by Kagan and Soai, is already being used widely by the pharmaceutical industry. This is relevant for the manufacturing of all other substances that are meant to interact with living organisms, including flavours, fragrances and agricultural chemicals like pesticides.

1. Nobel Prize in Chemistry 2026:

Mirror-Image Molecules and the Chemistry of Life

Source: The Hindu

GS: GS-3 — Science & Technology | Biotechnology | Pharmaceutical Chemistry

Context: Henri B. Kagan of France and Kenso Soai of Japan were awarded the 2026 Nobel Prize in Chemistry for discovering **non-linear effects and autocatalysis in asymmetric organic synthesis**, helping explain how life can favour one mirror-image form of a molecule.

1. Chirality: The Basic Concept

1. **Chirality:** Some molecules exist in two forms that are mirror images of each other but cannot be superimposed, similar to the left and right hands.
2. **Enantiomers:** These two mirror-image forms are called enantiomers. They have the same chemical composition but can behave differently in biological systems.
3. **Homochirality:** Living organisms predominantly use only one form. For example, proteins contain one specific form of amino acids.
4. **Biological importance:** The same molecule in its two forms can have very different effects on the human body.

2. What Did Kagan and Soai Discover?

1. **Kagan's contribution:** Kagan showed that a small initial difference between the two mirror-image forms could be **amplified**, producing a much larger imbalance.
2. **Soai's contribution:** Soai discovered an **autocatalytic reaction**, where the product of a reaction itself acts as a catalyst and promotes formation of more of the same molecular form.
3. **Non-linear effects:** A very small initial asymmetry can therefore produce a disproportionately large difference in the final products.
4. **Scientific significance:** Their work provided a possible chemical explanation for how **homochirality** could emerge naturally.

3. Why Is This Important for Medicines?

1. **Different effects:** Two enantiomers of the same drug can have different therapeutic effects or side effects.
2. **Thalidomide example:** Thalidomide demonstrated the danger of molecular handedness, as its use during pregnancy was associated with severe birth defects.
3. **Drug manufacturing:** Producing predominantly the desired enantiomer allows pharmaceutical companies to make medicines with greater precision.
4. **Wider applications:** Chirality is also important in **flavours, fragrances, agrochemicals and other biologically active substances**.

4. Significance for Understanding the Origin of Life

1. **Long-standing puzzle:** Scientists have long wondered why life overwhelmingly uses one molecular form rather than an equal mixture of both.
2. **Chemical amplification:** Kagan and Soai showed how a tiny initial imbalance can be amplified through chemical reactions.
3. **Origin-of-life research:** Such autocatalytic processes offer clues about how molecular asymmetry may have developed before complex life emerged.
4. **New research direction:** The work connects **organic chemistry, biochemistry and origin-of-life studies**.

MPC'S AUG 5, OCT 7 DECISIONS WERE BOTH UNANIMOUS

Dovish in August to hawkish: How MPC flipped in 2 months

Siddharth Upasani
New Delhi, October 7

IT WAS almost a foregone conclusion that the Reserve Bank of India (RBI) would increase the policy repo rate by 25 basis points (bps) to 5.5% on Wednesday. What was not as widely expected was that the Monetary Policy Committee (MPC) would also make the policy stance more restrictive—from 'neutral' to 'calibrated tightening'.

This shift is important. As Governor Sanjay Malhotra said, interest rate cuts are now "off the table in the near term."

According to Madhavi Arora, Chief Economist at Emkay Global Financial Services, the change means RBI has "clearly prepared markets for a higher-for-longer interest rate environment".

While some economists did and continue to predict only a shallow rate hike cycle of 50 bps or so, markets had already priced in a long-ish hiking cycle of at least 100 bps. This was despite the MPC's unexpected dovishness in August, when it said there were "little signs of generalisation of price pressures so far"—an assessment that left some economists unconvinced.

Generalisation of inflation means higher prices spreading to other parts of the CPI basket.

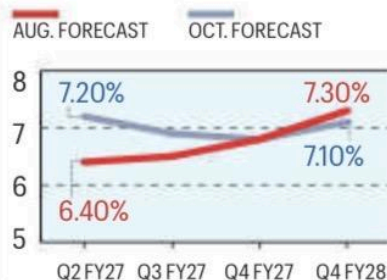
• How CPI, growth forecasts have changed

INFLATION FORECAST



SOURCE: RBI

GROWTH FORECAST



prices of 314 of the 358 items were higher in August compared to July. In February, this number was 236. Data for September may show more of the same.

Little change in data

When the MPC last met, it had with it the Consumer Price Index (CPI) inflation data for June, which had risen to 4.38% from 3.93% in May.

Meanwhile, Wholesale Price Index (WPI) inflation had edged up similarly to 9.87% from 9.68%.

Sincethen, inflation developments on both fronts have not been outsized; while retail inflation has risen to 4.82% in August, wholesale prices rose by 9.92%.

The RBI is mandated to target a CPI inflation rate of 4% in the medium-term in a band of 2-6%.

Of course, the MPC must be forward looking and take a view

jected at 4.4% needs policy recalibration reinforces the hawkishness," said Puneet Pal, PGIM India Mutual Fund's Head of Fixed Income. Pal expects incrementally 75-100 bps of rate hikes over the next nine months.

But even back in August, these forecasts were not markedly different. Retail inflation was expected to average almost 5.6% in the three quarters starting October, while core inflation was seen at 4.3% this fiscal. But it is only now that the MPC sees "some evidence of elevated inflation expectations and generalisation of inflation".

What has materially changed is the growth outlook and major central banks having raised their own policy rates.

But the central bank focuses on domestic inflation and growth developments. And

2. RBI Turns Hawkish: Monetary Policy Shifts Towards Tightening

Source: Indian Express

GS: GS-3 — Indian Economy | Inflation | Monetary Policy

Context: The Reserve Bank of India (RBI) has shifted towards tighter monetary policy as inflationary pressures broaden, raising the repo rate to **5.50%** and moving from a **neutral to calibrated tightening** stance.

1. What Has Changed in Monetary Policy?

1. **Repo Rate:** Raised by **25 basis points from 5.25% to 5.50%**, increasing the cost of borrowing in the economy.
2. **Policy Stance:** Changed from **neutral to calibrated tightening**, signalling greater emphasis on controlling inflation.
3. **Other Rates:** The **Standing Deposit Facility (SDF)** is at **5.25%**, while the **Marginal Standing Facility (MSF) and Bank Rate** are at **5.75%**.
4. **MPC Decision:** The decision was **unanimous**, indicating broad agreement within the Monetary Policy Committee on the need for tighter conditions.

2. Why Did the RBI Turn Hawkish?

1. **Retail Inflation:** Consumer Price Index (CPI) inflation increased to **4.82% in August**, from **4.45% in July**, indicating renewed price pressures.
2. **Broadening Inflation:** The number of CPI items experiencing inflation above **4%** increased from **65 in January to 110 in August**, suggesting wider price pressures.
3. **Supply Risks:** Higher energy prices, West Asia-related disruptions, weak rainfall and El Niño risks could increase food and production costs.
4. **Inflation Expectations:** The RBI has observed signs of **generalisation of inflation**, increasing the risk that temporary price pressures become persistent.

3. Growth and Inflation Outlook

1. **GDP Growth:** FY27 real GDP growth forecast was raised from **6.7% to 7.1%**, reflecting stronger economic activity.
2. **Inflation Forecast:** FY27 CPI inflation forecast was raised to **5.2%**, indicating greater inflationary risks.
3. **RBI Target:** The RBI continues to target **4% CPI inflation**, with a tolerance band of **2% to 6%**.
4. **Growth-Inflation Balance:** Strong growth provides some room for monetary tightening, but excessive tightening could weaken consumption, investment and credit growth.

4. Impact of the Rate Hike

1. **Borrowing Costs:** Higher policy rates can increase interest rates on **home, vehicle and business loans**.
2. **Consumption and Investment:** Costlier credit can reduce household consumption and private investment, moderating demand.
3. **Inflation Control:** Tighter monetary conditions can help contain demand and **anchor inflation expectations**.
4. **Savings:** Higher interest rates can improve returns on **bank deposits and fixed-income instruments**.
5. **Economic Growth:** Prolonged tightening can slow credit and economic activity, requiring the RBI to balance **price stability with growth**.

Iceland courts India for geothermal, CCUS, 'carbon-to-stone' technologies

Saptaparno Ghosh
NEW DELHI

Iceland is confident about the opportunities emerging in India's evolving geothermal energy landscape and believes regulatory challenges can be overcome, Jóhann Páll Jóhannsson, Iceland's Minister for Energy, Environment and Climate, told *The Hindu* on the sidelines of his visit to New Delhi.

"It (potential challenges originating from India's regulatory framework) is

Iceland generates 70% of electricity from hydropower, 30% via geothermal

something that can be overcome", he said, adding Iceland had the legal expertise to support countries in developing regulatory frameworks for scaling up geothermal energy.

Mr. Jóhannsson also expressed confidence in India's carbon capture, utilisation and storage (CCUS),

pointing to opportunities for Reykjavik to deploy "tried and tested" technology, Carbfix, which converts captured carbon dioxide into stone.

He said Iceland built huge expertise in geothermal energy and wanted to export that knowledge to nations such as India with "large, untapped potential."

Iceland generates about 70% of electricity from hydropower and 30% from geothermal sources. India, meanwhile, has an estimat-

ed geothermal potential of about 10.6 GW, according to government data. He noted New Delhi was also committed to expanding geothermal energy.

Benefit from Carbfix

Mr. Jóhannsson highlighted Iceland's Carbfix technology, which converts carbondioxide into stone via a process that permanently mineralises the captured CO₂. He said the technology could be useful for sectors such as cement and steel in India.



3. India–Iceland Cooperation in Geothermal Energy and Carbon-to-Stone Technology

Source: The Hindu

GS: GS-2 — International Relations | GS-3 — Renewable Energy | Climate Change

Context: Iceland is looking to deepen cooperation with India in **geothermal energy and Carbon Capture, Utilisation and Storage (CCUS)**, particularly by sharing technological and regulatory expertise.

1. Two Technologies at the Centre of Cooperation

1. **Geothermal Energy:** It uses **heat from inside the Earth** to generate electricity or provide direct heat. Its major advantage is that, unlike solar and wind, it can provide relatively **continuous renewable energy**.
2. **CCUS: Carbon Capture, Utilisation and Storage** involves capturing carbon dioxide (CO₂) emissions, either **using the CO₂ as an industrial input or storing it permanently** instead of releasing it into the atmosphere.
3. **Carbfix Technology:** Iceland's Carbfix process dissolves captured CO₂ in water and injects it into suitable underground rocks, where it reacts with minerals and is **permanently converted into solid carbonate minerals**.
4. **Indian Relevance:** Geothermal energy can diversify India's renewable-energy mix, while CCUS is particularly relevant for **hard-to-abate sectors such as cement and steel**.

2. Why India Is Important in Geothermal Cooperation

1. **Large Resource Base:** India has an estimated theoretical geothermal potential of around **10.6 GW**, but this potential remains largely untapped.
2. **Geothermal Sites:** The Geological Survey of India has mapped **381 hot springs** and identified **42 promising geothermal areas** for further development.
3. **Puga Valley, Ladakh:** India commissioned its **first two geothermal wells**, each about **1,000 metres deep**, at Puga Valley in 2026. They are intended to support reservoir assessment and a proposed **1 MW demonstration project**.
4. **Policy Push:** The **National Policy on Geothermal Energy, 2025** provides a framework for exploration, drilling, research, pilot projects and private-sector participation, signalling a shift from resource assessment towards actual deployment.

3. What Iceland Brings to the Partnership

1. **Proven Geothermal Experience:** Iceland produces virtually all of its electricity from renewable sources, with approximately **70% from hydropower and 30% from geothermal energy**.
2. **Technology and Expertise:** Iceland can provide India with experience in **geothermal exploration, drilling, reservoir management and commercial utilisation**, areas where India is still developing capacity.
3. **Regulatory Experience:** Since geothermal development involves issues such as resource rights, drilling and environmental management, Iceland's regulatory experience can help India overcome **institutional and regulatory barriers**.

4. **Carbon Mineralisation:** Iceland's **Carbfix** technology provides a potential model for permanent CO₂ storage. Carbfix already applies its technology in Iceland and is developing applications for sectors including **cement, iron and steel**.

4. Why This Cooperation Matters for India

1. **Energy Security:** Geothermal energy can add a **reliable, indigenous renewable source** alongside solar, wind and hydropower, reducing dependence on weather-dependent generation alone.
2. **Hard-to-Abate Emissions:** CCUS can complement electrification and renewable energy in sectors such as **cement and steel**, where process emissions are difficult to eliminate completely.
3. **Technology Transfer:** Cooperation can accelerate India's movement from **geothermal resource mapping to commercial projects** through joint research, technical expertise and capacity building.
4. **International Climate Cooperation:** The partnership fits India's broader clean-energy transition and its commitment to **Net Zero emissions by 2070**, while strengthening India-Iceland cooperation in emerging green technologies.

Govt. opposes mercy petition of convict in CM assassination case

The Hindu Bureau

NEW DELHI

The Centre has opposed a plea by death-row convict Balwant Singh Rajoana seeking commutation of the death sentence awarded to him in the 1995 assassination of former Punjab Chief Minister Beant Singh.

Rajoana, who has been in custody for more than 30 years, approached the Supreme Court over the delay in deciding a mercy petition that has been pending before the President since 2012.

“We have objection to what they are demanding. Considering the prevailing situation in the State [Punjab], it will not be condu-

cive to take any decision,” Additional Solicitor-General K.M. Nataraj, appearing for the Centre, told a Bench headed by Justice Vikram Nath.

In view of the Centre’s opposition to the plea, the Bench, also comprising Justices Sandeep Mehta and Aparesh Kumar Singh, said it would proceed to hear the matter on merits.

“Now that they insist on commuting their death sentence to life, which you oppose, we will hear the matter on merits,” the Bench said.

The court posted the matter for hearing on October 28 after Mr. Nataraj sought time to prepare the case.

4. Mercy Petition and Pardoning Power of the President

Source: The Hindu

GS: GS-2 — Indian Polity | Constitution | Judiciary

Context: The Supreme Court is hearing Balwant Singh Rajoana's plea seeking **commutation of his death sentence to life imprisonment**, citing the prolonged delay in deciding his mercy petition, which has remained pending since 2012.

1. Pardoning Power of the President: Article 72

1. **Constitutional Power:** Article 72 empowers the President to grant **pardon, reprieve, respite and remission**, and to **suspend, remit or commute** a sentence.
2. **Scope:** It applies to **Court Martial cases**, offences concerning matters within the Union's executive power, and **all cases involving a death sentence**.
3. **Aid and Advice:** The President exercises this power on the **aid and advice of the Council of Ministers under Article 74**; it is not a personal discretionary power of the President. The Supreme Court affirmed this principle in **Maru Ram v. Union of India (1980)**.
4. **Purpose:** Clemency provides an opportunity to consider **humanitarian, constitutional and public-interest considerations** that may not have been fully reflected in the judicial sentencing process.

2. Five Forms of Clemency

1. **Pardon:** Completely removes the punishment and its legal consequences. It is the **widest form of clemency**.
2. **Commutation:** Substitutes a **lighter punishment for a heavier one**. Example: **death sentence to life imprisonment**. This is what Rajoana is seeking.
3. **Remission:** Reduces the **duration of the sentence** without changing its nature. Example: 10 years reduced to 6 years.
4. **Respite:** Awards a **lesser sentence because of special circumstances**, such as pregnancy or serious physical disability.
5. **Reprieve:** Provides a **temporary postponement of execution**, particularly to allow consideration of a mercy petition in a death-penalty case.

3. Judicial Review of Pardoning Power

1. **Not Absolute:** The President's clemency power is constitutionally broad, but **the manner in which it is exercised can be subjected to limited judicial review**. This was clearly established in **Epuru Sudhakar v. Government of Andhra Pradesh (2006)**.

2. **Grounds of Review:** Courts can intervene where the decision involves **mala fide action, arbitrariness, non-application of mind, irrelevant considerations, or exclusion of relevant material.**
3. **Kehar Singh Case (1988):** In **Kehar Singh v. Union of India**, the Supreme Court recognised that the President can independently examine the material relating to a case while exercising Article 72 power; this does not mean the President is acting as an appellate court.
4. **Delay and Article 21:** In **Shatrughan Chauhan v. Union of India (2014)**, the Supreme Court held that **undue and prolonged delay in deciding a mercy petition can violate Article 21** and may justify commutation of a death sentence.

4. **Rajoana Case: Why Is It Important?**

1. **Background:** Balwant Singh Rajoana was sentenced to death for his role in the **1995 assassination of Punjab Chief Minister Beant Singh.**
2. **Mercy Petition:** His mercy petition has remained pending before the President since **2012**, resulting in more than a decade of delay.
3. **Relief Sought:** Rajoana is seeking **commutation of death sentence to life imprisonment**, relying particularly on the prolonged pendency of his mercy petition.
4. **Current Issue:** The Centre has opposed the plea, while the Supreme Court has decided to examine the matter **on its merits.**

SBI software prevents Christian applicants from selecting 'ST option', alleges Arunachal forum

The Hindu Bureau
GUWAHATI

The Arunachal Christian Forum (ACF), an apex body of Christians in Arunachal Pradesh, has alleged that the State Bank of India's (SBI) digital banking software prevents followers of the religion from selecting the 'Scheduled Tribe (ST)' option while opening an account or updating their KYC (know your customer) details.

The ACF said the digital system automatically classifies an applicant as 'general' upon selecting Christianity as their faith.

In a letter to the regional manager of the SBI's office in Itanagar, the State's capital, ACF president James Techu Tara and secretary general Yomrik Lombi

The ACF said the software disables the ST option when an applicant selects Christian as their religion and warned of agitations if the issue is not rectified

warned of agitations if the public sector bank did not make the requisite technical corrections within 15 days. The SBI's regional office received the letter on October 5.

The ACF said the software disables the ST option when an applicant selects Christian as their religion. Pointing out that tribal status in Arunachal Pradesh was not contingent on religious affiliation under the Constitution

(Scheduled Tribes) Order of 1950, the forum said the software was "potentially discriminatory".

"The SBI is not the competent authority to de-list a tribal Christian customer who possesses a valid ST certificate. The bank cannot automatically classify a tribal Christian under the general category solely based on their declared religion," the ACF letter stated. The forum urged SBI authorities to examine the on-boarding logic, clarify whether any regulatory or Reserve Bank of India directive permits such classification and rectify the software to prevent religion and tribal status from being treated as mutually exclusive. In response, SBI officials said they were looking into the matter.

5. SBI Software and Digital Exclusion of Tribal Christians

Source: The Hindu

GS: GS-2 — Governance | Tribal Affairs | Social Justice

GS-4: Ethics | Technology and Public Accountability

Context: The Arunachal Christian Forum has alleged that SBI's digital onboarding system prevents applicants who select **Christianity** from simultaneously selecting **Scheduled Tribe (ST)** status, potentially pushing eligible tribal Christians into the General category.

1. What Is the Issue?

1. **Alleged Software Rule:** Selecting "Christian" reportedly makes the **ST option unavailable** in the digital application process.
2. **Wrong Classification:** Religion and tribal status are distinct identities. A person belonging to a notified ST does not automatically lose that status because of their religion.
3. **Digital Exclusion:** If the software denies the correct ST classification, an eligible citizen may face difficulty in **accessing banking services or completing KYC digitally**.

2. Why Is It Important?

1. **Constitutional Concern:** **Article 342** governs the identification of Scheduled Tribes. A software system should not create an eligibility rule that is not supported by law.
2. **Technology and Equality:** This shows how an apparently technical **software design choice can produce discriminatory outcomes**.
3. **Ethical Governance:** Digital systems must ensure **fairness, transparency, accountability and human verification**, especially where automated decisions affect citizens' rights or access to services.

Property taxation needs structural reform

A robust property tax system is vital for India's cities. Property tax is not just the most important own revenue source for India's municipal bodies, it is also critical to bridge the gap in urban investment as such investment depends on municipal creditworthiness. However, the property tax performance of India's municipal bodies has been poor – India's cumulative property tax was 0.15-0.2% of its GDP, whereas it was 0.6% in middle-income countries and 0.3% in low-income countries. Policy efforts have sought to improve the property tax performance of India's municipal bodies through technology and process-based reforms recommended by successive Finance Commissions and national schemes such as the Jawaharlal Nehru National Urban Renewal Mission and the Atal Mission for Rejuvenation and Urban Transformation. Yet, tax outcomes remain sub-optimal. Why?

Two recent studies offer insights – a working paper on Chennai's property tax by Nobel Laureate Esther Duflo and co-authors, and this writer's research on Bengaluru, Pune and Ghaziabad's property tax. Both studies found that technology and process-based reforms will keep yielding sub-optimal results unless backed by structural reforms. Firstly, Duflo and co-authors' research in Chennai found that municipal human resources are a critical determinant of property tax outcomes. It also finds that a municipality's own tax assessors achieve far better tax outcomes compared to



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The property tax performance of India's municipal bodies has been poor – India's cumulative property tax was 0.15-0.2% of its GDP

assessors from outsourced firms. The research conducted across Bengaluru, Pune and Ghaziabad finds that in addition to the issue of municipal human resource deficits, two other structural issues – irregularity in the conduct of elections and poor financial reporting practices – also impact tax outcomes.

Stages of property tax

There are three life stages of property tax – enumeration (identification of properties and maintenance of property records along with property details), property valuation and tax assessment, and tax billing and collection.

Technology has been a popular policy solution for improving enumeration. GIS-based mapping using satellite imagery and drones have been increasingly deployed to identify properties. However, such mapping exercises need to be accompanied by physical inspections conducted by municipal tax assessors; they also need to be repeated at regular intervals. But a perennial shortage of municipal staff, lack of requisite skills, and inadequate capacity building plague India's municipalities. While human resource outsourcing can be a substitute, its efficiency is limited as municipal assessors leverage institutional memory in a way that outsourced assessors cannot.

For valuation, the most common policy recommendation has been the capital valuation process, wherein a property is valued as per its stamp duty-linked 'circle rate' which is set and revised by the State revenue department at regular

intervals. But most municipal bodies follow a valuation method wherein the 'base rate' is defined in rupees per sq ft per month which is set by the municipality. Hence, tax buoyancy is determined by revisions to this base rate. But such revisions are infrequent compared to revisions in the stamp duty-linked circle rate. It was found that 'base rate' revisions did not take place across Bengaluru, Pune and Ghaziabad when there were no elected municipal councils. The link between municipal elections and tax performance is clear, at least for these three corporations. As delayed municipal elections are common, so is infrequent 'base rate' revision and lack of tax buoyancy.

Finally, for tax collections to be robust, collection efficiency needs to be strong. While extant recommendations include adoption of both online collection as well as outsourcing the collection to external vendors, efficiency remains poor. Even more concerning is the difficulty in arriving at credible collection efficiency estimates due to the absence of properly maintained financial accounts.

To sum up, technology and process-based reforms are not enough for improving tax outcomes. Structural reforms encompassing more human resources, timely elections, and publicly available financial data play very important roles. It is high time that policy interventions broaden their focus to structural reforms for all aspects of urban governance and finance, including property tax.

6. Property Taxation Needs Structural Reform

Source: The Hindu

GS: GS-2 — Urban Governance | Local Bodies | Fiscal Federalism

Context: Property tax is the most important untapped source of own revenue for Urban Local Bodies (ULBs), but weak assessment, poor collection and limited municipal capacity continue to constrain urban finances.

1. Why Property Tax Matters

1. **Major Own-Source Revenue:** Property tax is one of the most important revenues that municipalities can raise themselves. Strong own-source revenue reduces excessive dependence on State and Union government grants.
2. **Very Low Revenue Potential Realisation:** Property tax collection in India has remained around **0.15% of GDP** for decades, compared with about **0.3% in low-income countries and 0.6% in middle-income countries**.
3. **Large Collection Gap:** The 16th Finance Commission found that across **3,895 ULBs**, property-tax demand was **₹69,937 crore in 2022–23**, but only **₹36,662 crore** was actually collected, implying a collection of about **52% of demand**.
4. **Urban Development:** Better property-tax mobilisation gives cities predictable resources for sanitation, roads, drainage, water supply and other municipal services, while also improving their creditworthiness.

2. Why Property Tax Collection Is Weak

1. **Incomplete Property Database:** Many ULBs do not have complete and regularly updated records of properties, allowing properties to remain outside the tax net.
2. **Undervaluation:** Outdated valuation methods and infrequent revision of property values result in a tax base that does not adequately reflect actual urban property values.
3. **Weak Administration:** Shortage of trained municipal personnel, poor assessment systems and weak recovery mechanisms reduce the efficiency of tax collection. CAG audits have repeatedly identified deficiencies in assessment, levy, collection and accounting.
4. **Institutional Weakness:** Limited financial autonomy, inadequate municipal capacity and dependence on higher-government transfers weaken the incentive and ability of ULBs to systematically expand their own revenue base.

3. Technology Can Improve Collection, But Is Not Sufficient

1. **GIS-Based Mapping:** Geographic Information System (GIS) mapping, satellite imagery and digital property databases can help identify previously unassessed properties and create a comprehensive property register.
2. **Three-Step Process:** Effective taxation requires **property enumeration, scientific valuation/assessment, and billing and collection**. Digitising only one stage cannot solve the entire problem.
3. **Human Verification:** Technology can identify properties, but field-level verification, updating ownership records and resolving disputes still require trained municipal officials.
4. **Technology Plus Institutions:** Digital platforms should therefore be combined with professional municipal staff, transparent valuation rules, periodic reassessment and effective grievance-redressal mechanisms.

4. What the Latest Data Shows About Municipal Finances

1. **Low Own-Source Revenue:** The 16th Finance Commission notes that Own-Source Revenue (OSR) contributes around **51% of total municipal revenue overall**, but the share falls to only **32% in ULBs with populations below 5 lakh**.
2. **Property Tax Remains Underutilised:** The Finance Commission identifies property tax as having the **greatest revenue potential among local-body tax sources**, yet its potential remains substantially unrealised.
3. **Wide State Variation:** Property tax contributes **more than 60% of OSR in Bihar, Karnataka and Uttar Pradesh**, while its contribution is **below 10% in Rajasthan**, showing major differences in municipal revenue mobilisation.
4. **Current Fiscal Support:** For **2026–31**, the 16th Finance Commission has recommended about **₹3.56 lakh crore for ULBs**, including basic, performance, special infrastructure and urbanisation-premium grants. A part of the performance-linked support is tied to improving own-source revenue.

5. Structural Reforms Required

1. **Professional Municipal Capacity:** ULBs need trained tax assessors, financial officers and data-management personnel rather than relying excessively on temporary or outsourced arrangements.
2. **Regular Revaluation:** Property valuation and tax rates should be revised periodically so that municipal revenue keeps pace with urbanisation and rising property values.
3. **Performance-Linked Incentives:** The 16th Finance Commission's approach of linking part of local-body grants to **own-source revenue growth** can encourage States and ULBs to improve their revenue mobilisation.

4. **Transparent and Accountable Governance:** Regular municipal elections, timely audited accounts, stronger State Finance Commissions and greater financial autonomy are essential for making property taxation politically and administratively sustainable.