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Exploring the Symmetry and relationship among Harshad Numbers, Fortunate Numbers, Lucky Numbers, and Happy Numbers in Economics

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Abstract

This article explores the mathematical symmetry among these number types and their potential applications in economic modeling and decision-making. The study of mathematical sequences like Harshad numbers, Fortunate numbers, Lucky numbers, and Happy numbers offers a fascinating perspective on economic modeling. These numbers, while originating in pure mathematics, exhibit properties that can be mapped onto financial stability, market anomalies, and consumer behaviors. Future research can further explore how these numerical symmetries can enhance predictive economic models and decision-making frameworks. By integrating mathematical properties with economic principles, we can develop robust analytical tools that provide deeper insights into financial trends and policy-making, reinforcing the timeless connection between mathematics and economics.

***Keywords**:* Harshad numbers, fortunate numbers, lucky numbers, happy numbers

Introduction

Numbers hold a special place in mathematics and beyond, often carrying intriguing properties that spark curiosity and admiration. Among these, Harshad numbers, Fortunate numbers, Lucky numbers, and Happy numbers showcase fascinating symmetry, each offering unique perspectives into the structure and beauty of mathematics.

Numbers have always played a crucial role in understanding patterns, trends, and behaviors in various fields, including economics. Some special sequences of

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numbers, such as Harshad numbers, Fortunate numbers, Lucky numbers, and Happy numbers, exhibit intriguing properties that can be linked to economic phenomena. This article's goal is to investigate the mathematical symmetry between these number types and how they could be used in economic modeling and decision-making (Guy, 2004).

Harshad Number in Economic Cycles

A number that is divisible by the sum of its digits is called a Harshad number, often referred to as a Niven number. The term "Harshad" comes from the Sanskrit words "Har" (meaning "to take away") and "Shad" (meaning "joy"), implying that the number is divisible and leaves no remainder.

This property of self-sufficiency can be metaphorically linked to sustainable economic growth models. Economic cycles that exhibit self-sustaining growth, wherein the aggregate income remains proportional to total consumption, can be associated with Harshad number properties. For instance, an economy where tax revenues grow in direct proportion to public expenditure might demonstrate a similar divisible structure, leading to balanced economic cycles (Rosario, 2019). Example of Harshad number in base 10:

The sum of its digits in 18 is 1 + 8 = 9, and 18 is divisible by 9, so 18 is Harshad number. Likewise, 12 and 21 are also Harshad numbers.

Definition:

A number n in base 10 is also a Harshad number if:

$n \mod (\text{sum of n digits}) = 0$.

Examples:

The sum of the digits in 21 is 2+1=3. Since $21 \mod 3 = 0$, so 21 is also a Harshad number. The sum of the digits in 1729 is 1+7+2+9 =19, so 1729 is also a Harshad number.

Non-Examples:

The sum of the digits in 19 is 1+9=10 and $19 \mod 10 \neq 0$, so 19 is not Harshad number. The sum of the digits in 23 is 2+3=5 and $23 \mod 5 \neq 0$, so 23 is not Harshad number.

Algorithm to Check a Harshad Number

Determination of Harshad number:

Calculate sum of digits in it.

Divide the original number by calculated sum.

Check the remainder whether zero or not.

Symmetry: The harmonic link between an integer and the sum of its digits is what gives Harshad numbers their symmetry. This interplay often reveals surprising patterns within number systems, especially in sequences where consecutive numbers are Harshad. The distribution of Harshad numbers in different bases forms a structured yet irregular pattern, underscoring a subtle numeric symmetry (Rosario, 2019).

Fortunate number

A Fortunate number is defined as the smallest integer greater than 1 (when added to the product of all primes less than or equal to a given number) produces another prime. For example, the sum of all prime numbers that are less than or equal to 5.

Adding 2 yields 32, which is not prime. Adding 3, however, yields 33, which is also not prime. The smallest such is 13, and thus 13 is the Fortunate number for. A Fortunate Number is a concept from number theory, exactly related to prime numbers and sequences.

The Fortunate number for a given integer n is the smallest integer F(n) >1 such that

$$F(n)+P(n) = P(n)$$

is a prime number. P(n) is the product of the first n prime numbers.

Fortunate Numbers and Financial Stability

Fortunate numbers are the smallest prime numbers greater than the P(n). These product numbers often appear in the study of economic stability and investment growth. The concept of Fortunate numbers suggests a safety buffer—akin to an economic reserve or financial cushion—where optimal investment strategies ensure minimal risk exposure while maximizing prime opportunities. The predictive nature of these numbers can assist in financial modeling, especially in long-term growth projections and investment portfolio balancing.

Primorial

The primorial P(n) of n is denoted as P(n) = p1×p2×............×P(n) where $p_1, p_2, p_3 \cdots\cdots p_n$ are the first n prime numbers.

For example:

P(1) =2 (the first prime number)

P(2)=2×3=6

P(3)=2×3×5=30

P(4)=2×3×5×7=210

Example

Let's compute a Fortunate number for n=3:

Compute P(3)=2×3×5=30.

Thus, the Fortunate number for n=3 is F(3) =7.

Observations

Fortunate numbers are conjectured to always be integers greater than 1, though this has not been formally proven.

Symmetry: The prime-generating nature of Fortunate numbers highlights a symmetry in their reliance on the multiplicative structure of smaller primes. They represent a fine compromise between the organized evolution of products and the chaotic distribution of primes.

Lucky Number

Lucky numbers are integers generated by a sieving process similar to that of Eratosthenes for primes but with a different elimination rule. Every second natural number is removed (leaving 1, 3, 5, 7, 9, etc.), followed by every third remaining number. The resulting sequence includes numbers like 1, 3, 7, 9, 13, etc.

A Lucky Number is a special sequence of numbers generated by a process of elimination similar to the sieve of Eratosthenes, but instead of eliminating multiples, it eliminates numbers based on their position in the list (Yang, 2011).

Generation of Lucky Number

Start with a natural number: 1,2,3,4,5,6,7, …

Eliminate every second number, leaving: 1,3,5,7,9, …

The second number in this process is 3. Eliminate every third number leaving: 1,3,7,9,13, …

Eliminate every seventh number in the current list.

Continue this process indefinitely.

The numbers that remain are called Lucky Numbers.

Example

The first few steps generate the sequence as follows:

Start: 1,2,3,4,5,6,7,8,9,10,11, …

Eliminate every second number: 1,3,5,7,9,11, …

Remove every third number from: 1,3,7,9,13,,,,,,,,,,

Eliminate every seventh number: 1,3,7,9,13,15,21, …

First few lucky numbers are:

1,3,7,9,13,15,21,25, …

Key Properties (Kaprekar,1955)

Not all Lucky Numbers are Prime: Unlike primes, lucky numbers are not determined by divisibility but by their position in the list.

For example, 7 is both a prime and a lucky number, but 9 is lucky and not prime.

Infinite Sequence: There are infinitely many lucky numbers, just as there are primes.

Odd Numbers: Lucky numbers, by construction, are always odd after the first step since all even numbers are eliminated.

Lucky Numbers and Market Anomalies

Lucky numbers are a sequence made by a sieving process similar. Their unpredictable yet structured appearance mirrors market anomalies and speculative bubbles in economics. Stock market trends often exhibit patterns that, while appearing random, follow underlying deterministic principles (Yang, 2011). The structure of Lucky numbers can be applied to understand consumer behaviors, pricing strategies, and economic fluctuations influenced by psychological factors and chance occurrences (Guy, 2004).

Applications in economics

Lucky numbers are mostly a mathematical curiosity, studied in number theory. They sometimes serve as an alternative filter for teaching purposes.

Symmetry: The symmetry of Lucky numbers lies in the iterative sieving process, which generates a self-similar pattern of elimination and preservation. This recursive elimination produces a structured set of integers that bears resemblance to the distribution of primes (Gilmer, 2013).

Happy Number

A Happy number are recurrently replaced by the sum of the squares of its digits (Gilmer, 2013). For instance:

Starting with 19:

Therefore, 19 is a Happy number

A number determined by the following procedure is known as a "Happy Number": Replace the number with the sum of the squares of its digits, starting with any positive integer. Continue doing this until the number equals 1 (where it will stay) or it keeps looping in a cycle without 1. If a number ultimately reaches 111, it is happy. If not, it's referred to as a sad or miserable number (Wolfram Research, 2009).

How to Determine Whether a Number Is Happy

Start with given number.

Calculate the sum of squares of its digits.

Check whether the result is 1 or not. If yes, the number is happy.

If the result forms a cycle (typically ending at 4), the number is unhappy.

Repeat the process until a conclusion is reached (Planet Math. 2016).

Example: Checking if 19 is a Happy Number

19: $1^2 + 9^2$=1+81 , 100: $1^2 + 0^2$ =1

Since the process reaches 1. The first few happy numbers are

1,7,10,13,19,23,28,31,32,44, …

Properties

All numbers eventually fall into one of two categories:

Reach 1: Happy numbers.

Enter a cycle (e.g., 4→16→37→58→89→145→42→20→4 : Unhappy numbers.

Infinite Happy Numbers: There are infinitely many happy numbers.

Base Dependence: Happiness is dependent on the base of the number system.

Happy Number and Consumer Confidence

Happy numbers are numbers that eventually lead to 1 when iterated under their sum of squares. This cyclic behavior can be related to consumer confidence cycles in economics. Just as Happy numbers stabilize at 1, a well-functioning economy stabilizes when consumer sentiment is strong and self-reinforcing. Understanding this pattern can help policymakers craft strategies to boost economic optimism, thereby stimulating spending and investment, leading to overall economic stability and growth (Wolfram Research, 2009).

Methodology

Books, journals, and websites are all cited in this paper. Illustrations are used to demonstrate how different numbers are related and their respective application in economics.

Discussion

The symmetry of Harshad numbers, Fortunate numbers, Lucky numbers, and Happy numbers provides a window into the profound beauty of mathematics. Whether through digit relationships, prime interplays, sieving processes, or cyclic behaviors, these numbers reveal ordered structures amidst apparent randomness. Exploring these properties enriches our understanding of number theory and mathematical aesthetics, inviting deeper investigation into their patterns and implications.

In the context of economics, these specific number classifications do not have established applications or recognized relationships. Economic models and analyses typically employ mathematical tools such as calculus, statistics, and linear algebra, focusing on continuous variables and probabilistic methods rather than the discrete properties of specific number classifications like Harshad or Happy numbers (Guy, 2004).

Relations and Intersections

Commonalities:

All these types focus on special properties of integers, often linked to divisibility, digit manipulation, or prime properties. A number can belong to multiple categories simultaneously (e.g., a Harshad Number that is also Happy or Lucky).

Overlaps:

Harshad and Happy Numbers: Some Harshad Numbers are also Happy Numbers (e.g., 1 and 9).

Harshad and Lucky Numbers: Numbers like 1 can fall under both categories due to their simplicity.

Happy and Fortunate Numbers: There is no intrinsic connection, but some Fortunate Numbers may be Happy (Kaprekar,1955).

Distinctiveness:

Fortunate Numbers arise from primes and multiplication, whereas the others focus more on individual digit properties or sieves (Rosario, 2019).

Conclusion

While there is no formal or inherent relationship among Harshad Numbers, Fortunate Numbers, Lucky Numbers, and Happy Numbers, there can be overlaps by chance. These overlaps can occur if a number independently satisfies multiple definitions. Further exploration in specific ranges may reveal intersections, but they are not guaranteed due to the independent nature of their definitions.

Conflict of Interest Statement

The authors declare no conflict of interest related to the conduct, analysis, or publication of this study

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