Aalto University
School of Business

Bachelor's Programme in Economics

Virtual Economies and Macroeconomic Dynamics: Analyzing the Money Market and Inflation in Old School RuneScape

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Bachelor's Thesis

2025

Aalto University
School of Business

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Title Virtual Economies and Macroeconomic Dynamics: Analyzing the Money Market and Inflation in Old School RuneScape

Degree programme Economics

Major Economics

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Date 20.8.2025 **Number of pages** 36 **Language** English

Abstract

This thesis examines the macroeconomic dynamics of Old School RuneScape (OSRS). The game has a large-scale virtual economy, which is inspected through established economic theories. By constructing a Consumer Price Index (CPI) from long-standing in-game items, the thesis quantifies inflation and deflation trends from 2015–2025. Results show inflationary cycles during periods of rapid gold generation, followed by deflation after the introduction of monetary controls such as the Grand Exchange tax. The Quantity Theory of Money explains long-run price movements, while the Aggregate Supply–Aggregate Demand framework captures short-term update-driven shocks. Analysis of bond price trends reveals strong links between OSRS's virtual economy and real-world currency markets. Jagex, who is the game's developer, effectively acts similarly to a central bank, managing money supply and price stability through gold sinks and monetary interventions. The findings suggest that, despite design-specific constraints, traditional macroeconomic models are applicable to virtual economies, offering valuable insights into both digital and real-world monetary systems.

Keywords Macroeconomics, Old School Runescape, Virtual economy, Inflation, Consumer Price Index, CPI

Contents

Symbols and Abbreviations

Symbols

M	Money supply
V	Velocity of money
P	Price level
Y	Output

Abbreviations

API	Application Programming Interface
AS–AD	Aggregate Supply–Aggregate Demand
CPI	Consumer Price Index
ECB	European Central Bank
GE	Grand Exchange
GP	Gold Piece (OSRS currency)
MMORPG	Massively Multiplayer Online Role-Playing Game
OSRS	Old School RuneScape
PvM	Player versus Monster
RWT	Real-World Trading
USD	U.S. Dollar
YTD	Year-To-Date

Glossary of Key Game-Specific Terms

Botting The use of automation software (bots) to perform in-game tasks such as skilling or combat.

Gold Farming The practice of systematically generating in-game currency (GP) to sell for real-world money. This is against the game rules.

Gold Sink Any in-game mechanism designed to remove GP from the economy. Gold sinks help control inflation by reducing the total money supply.

Grand Exchange (GE) The in-game auction house in OSRS where players can buy and sell items. Prices are determined by player-to-player trade and respond to supply and demand dynamics.

Money Faucet Any in-game mechanism which increases the GP supply within the economy.

Old School Bond A tradeable in-game item purchased with real-world currency from Jagex. Only legitimate connection between in-game and real-world currency.

Player versus Monster (PvM) A game activity involving combat between players and computer-controlled monsters. PvM activities are a major source of high-value drops and GP.

Skilling The process of training non-combat skills in OSRS to gather resources or level up. Skilling is often used to generate GP.

Real-World Trading (RWT) The exchange of in-game currency, or services for real-world money through unofficial channels.

1 Introduction

In recent years, virtual worlds have evolved not only as entertainment platforms but also as places for complex economic activity. Studying these economies offers insight into real-world mechanisms in controlled, observable environments, where rules and player behavior simulate human responses. Among these is Old School RuneScape (OSRS), a massively multiplayer online role-playing game (MMORPG) developed by Jagex Limited. OSRS stands out as a particularly rich case study for observing macroeconomic behavior in a virtual world.

Scholars such as Castronova [1], Lehdonvirta [2], and Heeks [3] have explored how virtual economies mirror, distort, or challenge traditional economic theory. Their work concludes that macroeconomic models such as including the Quantity Theory of Money, supply-demand analysis, and monetary policy analogies can be helpful in virtual environments as well. Although, often they need some modifications. For example, articles on virtual worlds [4, 5] demonstrate how inflation in virtual economies can be analyzed through money supply growth, while [3] discusses how game developers like Jagex act similarly to central banks in managing virtual currencies through game updates and money sinks.

This thesis aims to explore how the OSRS money market functions, how inflation develops, could be measured and is managed within the game. Additionally it is studied how these patterns reflect or diverge from real-world macroeconomic models. This thesis is based on literature in virtual economy research, analysis and classical macroeconomic theory to analyze OSRS as a simplified but revealing economic system.

1.1 Old School RuneScape and Its Economic System

OSRS is a fantasy MMORPG operated and developed by Jagex from the 2007 legacy build of RuneScape. It was launched in 2013 as a reaction to a fan poll, and has since been one of the longest-running online games with millions of players worldwide to this day. The game can be played for free with limited access to the game or by paying

monthly subscription to access the whole game which currently costs $13.99. The in-game economy within OSRS contains a virtual currency known as gold pieces (GP) or coins, which players use to buy and sell goods and services. Unlike many game economies controlled by the developer, OSRS has a player-controlled market, in which prices are determined by player-to-player trade and the Grand Exchange (GE), a central trading hub serving as an auction house [6].

GP enters the economy primarily through in-game activities such as monster drops, skilling, and player-versus-monster (PvM) content. To counterbalance this, Jagex has implemented gold sinks, like repair fees, item upgrades, and taxes [7]. A notable example is the Grand Exchange tax and item sink system introduced in 2021 [8], which functions similarly to real-world monetary controls by removing GP from circulation.

Still, inflationary pressures comes when money generation seems to be greater gold removal. The economy is further influenced by real-world trading (RWT) and automation (botting), which can distort price levels and labor markets—an issue extensively documented by [3] and [2]. In better detail, botting refers to the use of automation software to perform in-game tasks, bypassing the time and effort required from human players.

Thus, OSRS offers a unique hybrid economic system. While the economy is decentralized and governed by supply and demand, it is also subject to top-down interventions by developer Jagex, who act similarly to a central bank [3]. This combination offers a rich field of study in which to examine macroeconomic theories in an artificial, yet deeply interactive, economic environment.

2 Theoretical Framework

In this section the basic macroeconomic theory which is possibly relevant for this thesis will be discussed. Additionally, the previous literature related to the suitability of the models in virtual economies is discussed.

2.1 Macroeconomic Concepts

This subsection introduces key macroeconomic theories and models that are used for analyzing price levels, money supply, and inflation in the economy of Old School RuneScape (OSRS). Suitability of these models will be evaluated in Section 5.

2.1.1 Inflation and Price Levels

Inflation is typically defined as a sustained increase in the overall price level of goods and services in an economy which leads to a reduction in the purchasing power of money. It is commonly measured using price indices, such as the Consumer Price Index (CPI), that tracks changes in the price of a representative basket of goods over time [9, 10].

2.1.2 Quantity Theory of Money

The Quantity Theory of Money provides a basic relationship between the money supply and the price level, which is commonly expressed by the identity:

$$MV = PY$$

where M is the nominal money supply, V is the velocity of money, P is the price level, and Y is real output [11, 12]. The theory suggests that, if V and Y are fixed, increases in M lead directly to equal increases in P. This model has been central in classical and monetarist economic theory [13]. It was founded by Fisher [11] and then later Friedman [12] proved the usability of the model.

2.1.3 Aggregate Supply and Aggregate Demand (AS–AD)

The AS–AD model describes how aggregate demand and aggregate supply interact to determine output and the overall price level in an economy [9, 10]. Shifts in aggregate demand or supply result in changes to equilibrium prices and output, offering a framework to understand economic fluctuations caused by shocks. In virtual economies, events such as updates or rule changes can be viewed as supply or demand shocks within this model.

In modern macroeconomics, the AS curve is often derived from a Phillips Curve framework, linking inflation and output through wage-setting behavior [14]. When applied to real economies, this means that low unemployment leads to higher wage demands, which can feed into inflation as firms raise prices to maintain profits. In virtual economies like OSRS, analogs include the supply of GP as income, labor-supply shocks from botting, and the demand for high-end content as economic "employment." While synthetic, similar tensions exist, when players can easily generate gold. In other words labor is cheap. In this case inflation follows unless countered by sinks.

2.1.4 Monetary Policy and Central Banks

Modern monetary policy refers to the actions of central banks to manage the money supply and interest rates to achieve macroeconomic objectives such as price stability and economic growth [15]. Classical tools include open market operations, interest rate setting, and reserve requirements. These instruments do not exist in OSRS. In virtual economies like OSRS, there is no formal central bank, but the game developer acts similarly through mechanisms that affect money supply and demand, such as gold sinks and taxes.

One key tool for monetary policy is the Taylor Rule [16]. The Taylor Rule, proposed by economist John B. Taylor, provides a systematic and rule-based approach for central banks to set short-term nominal interest rates in response to deviations of actual inflation from the target inflation rate and actual output from potential output.

In real-world economies, the Taylor Rule helps guide policy decisions by linking

interest rate setting to measurable economic conditions. Most of the central banks do not admit using Taylor Rule for their monetary policy decisions but their results seem to be following it.

2.1.5 Consumer Price Index (CPI)

CPI measures the average change in the prices of a basket of goods and services consumed by households over time. The CPI serves as a primary indicator of inflation in most economies and is constructed by selecting a representative basket of goods, assigning weights, and applying an index formula [17, 18].

2.2 Application to Virtual Economies

Virtual economies have been shown to exhibit macroeconomic behavior comparable to real-world systems. Early foundational work by Castronova showed that virtual worlds like *EverQuest* and *Ultima Online* developed functioning economies where currencies and goods had real monetary value and followed familiar economic laws [1, 4].

Lehdonvirta and Castronova argue that macroeconomic models, such as the Quantity Theory of Money and AS–AD framework, can meaningfully describe virtual economies, although adaptations are often necessary. This is due to designer intervention and rule-based constraints [2]. They highlight that, while virtual currencies can inflate due to uncontrolled money creation for example, botting, developer actions serve as monetary policy tools, with game updates, taxes, and gold sinks acting like fiscal and monetary tools. This reflects what Bilir [7] describes as RuneScape's faucet-drain model, where currency enters through gold-generating activities (faucets) and exits via gold sinks (drains) in an effort to stabilize the money supply and mitigate inflation.

Heeks explores how virtual economies are intertwined with real-world economies through practices such as real-world trading (RWT) and gold farming. Gold farming refers to players (often in low-income countries) who accumulate in-game currency and sell it for real-world money, often in violation of the game's terms of service.

These activities blur the boundary between digital and physical markets and introduce external pressures on price levels within the game world [3]. In the case of RuneScape, RWT and botting have historically contributed to inflation and wealth concentration, requiring interventions from the game's developer, Jagex [7]. These interventions have typically included bot detection, bans, and trading limits to new accounts.

CPI construction in virtual economies faces similar challenges as in real-world contexts. These issues include: choosing representative items, dealing with product turnover for example, new items or item nerfs, and accounting for player substitution behavior. The IMF's CPI guidelines and the Boskin Commission's findings on index biases are relevant for designing a robust virtual CPI that accurately reflects in-game inflation [17, 18].

In conclusion, while virtual economies provide possible ground for applying macroeconomic theories, they also introduce unique complexities due to their unique designs and centrally controlled nature.

3 The Economy of Old School RuneScape

As Section 2 introduces the theoretical foundations of macroeconomics which could possibly be applied to virtual systems, this section examines how those principles manifest in the specific context of Old School RuneScape (OSRS). OSRS's economic design is explored by focusing on its player-driven markets, monetary mechanisms, and inflationary dynamics through the lens of models introduced.

3.1 Game Overview

OSRS is a massively multiplayer online role-playing game (MMORPG) developed and maintained by Jagex. It was launched in 2013 following a community poll, restoring the 2007 version of the original RuneScape game to meet player demand for a more nostalgic and mechanically simpler experience [6]. OSRS has grown into one of the most popular MMORPGs worldwide, with tens of millions of registered accounts and a consistently active player base still in 2025.

The game world, known as Gielinor, offers players a wide array of activities, including combat, skilling, questing, and trading. OSRS is designed as a sandbox environment where players are free to choose their play style and economic role. The in-game currency is called gold pieces (GP), and it serves as the primary medium of exchange for goods and services.

Players can earn GP through various ways, player-versus-monster (PvM) combat, gathering resources through skilling, for example: mining, fishing, woodcutting, or through trade. Unlike some online games where prices are set only by developers, OSRS features a largely player-driven economy where item prices are determined by supply and demand dynamics in the player community.

Central to OSRS's economy is the Grand Exchange (GE), an in-game auction house that allows players to buy and sell items with minimal transaction costs. Introduced in the original RuneScape in 2008 and added over to OSRS in 2015, the GE facilitates large-scale trade and functions as the core marketplace for the game's economy [19]. GE allows players to create listings which then can be bought by another player. The

Figure 1: The GE interface, showing sell and buy offers. Red indicates canceled trade by the lister, green successful trade, gray indicates outstanding trade and yellow partially completed trade [6].

buyer always gets the lowest priced listing and the lowest priced listing also is always sold first. Prices on the GE fluctuate based on player behavior. As shown in Figure 1, the GE provides players with a real-time interface to manage buy and sell offers. The color-coded statuses streamline transaction tracking and reflect market liquidity, mimicking modern financial systems. Figure 2 shows the actual sell interface of GE in which the pricing options and the calculated GE tax can be seen.

Gold pieces can be generated by in-game activities at a theoretically unlimited rate, but gold is also removed from the game via gold sinks mechanisms such as item repair costs, construction materials, and taxes notably the Grand Exchange tax introduced in 2021 that act to stabilize the money supply and limit inflation [8].

3.2 Market Mechanics

As previously discussed, the economy of OSRS is characterized by its player-driven market, where supply and demand set prices with minimal direct price controls from the developer. The key trading hub is the GE, introduced to OSRS in 2015, which functions as a centralized auction house where players can buy and sell items [6]. The GE facilitates the trade of resources, equipment, and consumables, and its price system is dynamic: item prices adjust in response to aggregated player transactions.

Speculative behavior is common within the OSRS economy. Players frequently

Figure 2: GE sell interface showing the pricing options for seller and calculating the GE tax. [6]

buy items not only for consumption but also as investments, hoping to profit from price changes driven by market trends or anticipated game updates. Hoarding of rare or high-demand items can lead to temporary supply shortages and price spikes, a behavior analogous to speculative bubbles in real-world markets.

Additionally, there is often a gap between the slow buy and sell prices of items. This offers players a way to profit by "flipping" items. They slow buy items as players are eager to sell their items instantly and then selling them slowly with higher price. Therefore, profiting the margin.

Game updates and developer actions frequently act as economic shocks. For

example, the introduction of a new boss or item can cause immediate changes in supply and demand for related goods. For example, the newly introduced boss may require a specific type of weapon which then causes a shock in demand. Additionally, the new boss might drop a large quantity of some resource and therefore causing supply shock. Similarly, adjustments to drop tables, nerfs, or new gold sinks can influence the flow of items and currency in the economy, leading to price volatility. These updates could be viewed through the AS–AD framework introduced in Section 2.1.3.

GE introduced a convenience fee on all transactions to serve as both a user cost and a gold sink, helping to control inflation. Initially, when the GE launched in February 2015, this fee was set at 1% for all completed buy and sell offers. However, as inflationary pressures continued and gold flow within the game escalated, Jagex increased the fee to 2% in May 2025 [6].

This adjustment effectively doubled the rate at which GP is removed from circulation per trade, increasing the fiscal impact of each transaction. By raising the convenience fee, Jagex enhances the efficiency of the GE as a monetary-policy tool, acting similarly to a contractionary tax, without altering core gameplay mechanics. This change reinforces Jagex's role as an undisclosed "central bank," dynamically tuning policy instruments to maintain price stability within the OSRS economy. [8].

While the market is largely open and decentralized, Jagex retains significant indirect control through its ability to modify game mechanics, which in turn influences economic variables like supply, demand, and the money supply.

3.3 Inflation Dynamics in OSRS

Inflation in OSRS refers to the sustained rise in the general price level of in-game goods and services, driven by an increase in the supply of gold pieces (GP) relative to the availability of goods. As in real economies, inflation in OSRS reduces the purchasing power of currency, making goods and services more expensive over time.

If the increasing money supply is not balanced by equivalent growth in goods or effective gold removal mechanisms, inflation results. In OSRS, item production

(real output) is constrained by game mechanics: rare drops remain rare, and resource gathering is limited by time and effort. Thus, when GP enters the economy faster than goods are produced, the price level of goods on the Grand Exchange tends to rise.

Jagex has implemented gold sinks to combat inflation. These include item repair costs, expensive skill training methods for example, skills like construction and herblore, and the previously mentioned Grand Exchange tax. The tax removes a portion of GP from circulation with every transaction, functioning similarly to a transaction tax or a contraction monetary policy tool. Additionally, many other in-game activities cost GP and if the player dies they must pay certain amount of GP to retrieve their items. Furthermore, Jagex has hosted charity campaign called Well of Goodwill in which Jagex donated one dollar to charity per one million GP donated by players [6]. This GP was then deleted from the game.

Inflation in OSRS is further affected by external factors. Real-world trading (RWT) and botting contribute to artificial increases in gold supply. These practices flood the economy with GP generated at high rates through automated gameplay, exacerbating inflationary pressures and leading to greater wealth concentration among certain players [3]. Botting typically increases the amount of lower tier items entering the market which causes the prices of these items to drop. From an economic standpoint, botting can also be seen as a player's attempt to minimize the disutility of repetitive in-game labor for example skilling, not just a way to gold farm for real-world currency. Therefore they automate the accumulation of resources while reserving effort for high-value content like PvP or raids.

Game updates act as both demand and supply shocks. The release of new items or bosses can temporarily inflate prices of related goods due to surging demand, while updates that nerf GP sources or introduce gold sinks can have deflationary effects. Overall, inflation in OSRS reflects a complex interplay between money supply growth, constrained item production, player behavior, and developer interventions.

4 Constructing a CPI for OSRS

4.1 Real-World CPI Methodology

The Consumer Price Index (CPI) is one of the most widely used measures of inflation in real-world economies. It tracks the average change over time in the prices paid by consumers for a fixed basket of goods and services [17]. The CPI serves as a key tool for assessing price stability, guiding monetary policy, and indexing wages, pensions, and contracts to maintain purchasing power.

Constructing a CPI involves several essential steps. First, a representative basket of goods and services is selected. This basket reflects the consumption patterns of a typical household and is based on expenditure surveys. Each item in the basket is assigned a weight corresponding to its share in total consumer spending [17, 18]. The choice of items and weights must be periodically updated to account for changes in consumption habits, the introduction of new products, and the obsolescence of others.

Second, prices for the items in the basket are collected regularly from a variety of sources. Statistical agencies ensure that prices are gathered in a consistent and reliable manner to reflect the true cost to consumers [18].

Third, price indices are calculated using index formulas. The most common is the Laspeyres index, which uses base-period quantities to weight prices. Alternative formulas, such as the Jevons or geometric mean index, may be used at lower aggregation levels to address issues like substitution bias [17, 18].

Real-world CPI construction faces challenges, including:

- **Substitution bias:** Consumers may switch to cheaper alternatives when relative prices change, which the fixed basket does not capture.
- **Quality change:** Improvements or deteriorations in product quality can affect prices, complicating comparisons over time.
- **New goods:** The introduction of new products requires basket updates to remain representative.

Addressing these challenges often involves using greedy pricing techniques, regular basket revisions, and applying different index formulas that account for consumer substitution behavior [17, 18].

These principles provide a foundation for constructing an analogous CPI in the context of the OSRS virtual economy, adapting methods to fit the specific features of in-game markets and player consumption patterns.

4.2 Designing the OSRS-CPI

Constructing a CPI for OSRS requires adapting principles from real-world CPI design to the unique characteristics of a virtual economy and in especially for the case of OSRS. Several factors must be carefully considered to ensure that the index accurately reflects in-game price changes and economic conditions.

Selection of representative items A key challenge is determining which items form the OSRS consumption basket. In real-world CPIs, the basket reflects household spending patterns; similarly, the OSRS-CPI should capture the goods and services most commonly used by the average player. This includes items essential for skilling, combat, and progression. Consideration should also be given to frequently traded consumables and equipment.

Diversity of item categories To capture price movements across the game's economy, the basket should cover major categories:

- **Consumables:** Food, potions, and arrows
- **Equipment:** Common weapons and armor
- **Skilling resources:** Raw materials
- **Utility items:** Runes, teleport tablets

Basket size Real-world CPIs typically balance detail and practicality; similarly, the OSRS-CPI should be large enough to capture broad market trends without becoming unwieldy. A basket of approximately 20 carefully chosen items would offer a manageable scope while covering key areas of the economy. This size allows for tracking without excessive complexity in data collection.

Weighting Whereas real CPIs use expenditure shares, OSRS lacks official player expenditure data. As a practical approach, equal or category-based weights could be assigned in the case of OSRS. These can then be further refined with trade volume or price data.

Challenges specific to OSRS Designing the OSRS-CPI must address:

- **Item turnover:** New items enter the game, and some become obsolete (e.g., after nerfs or updates).
- **Speculation:** Prices may be volatile due to hoarding or update anticipation.
- **Quality change:** Item buffs or nerfs alter the effective value of goods.
- **Data Availability:** For best results the basket would contain items that have been in the game throughout the whole data window.

These factors mirror real-world CPI challenges like new goods bias and quality adjustment [17, 18].

4.3 Proposed OSRS-CPI basket

Based on these considerations, the following CPI basket is proposed:

- **Consumables, weight = 0.25:** Shark, monkfish, prayer potion (4), rune arrow, ranging potion (4)
- **Equipment, weight = 0.40:** Abyssal whip, dragon scimitar, rune platebody, dragon dagger (p++), Armadyl Crossbow, Bandos chestplate, Elysian spirit shield

- **Skilling resources, weight = 0.25:** Yew logs, coal, adamant ore, ranarr weed, raw karambwan
- **Utility, weight = 0.10:** Law rune, teleport to house tablet, Blood rune

These items are commonly used by a wide range of players and represent key sectors of the OSRS economy. Additionally, all of these items have been in the game throughout the history of GE. So, there is data on which the basket can be built on. Data for the construction of the basket will be sourced through the OSRS Wiki's API [20].

The fact that the items have been in the game so long also comes with issues for the basket. Better items have been released to the game and therefore surpassing these items. Additionally, many of these items are typically easy to bot, which has affected price for example runes. Future refinements of the basket could include adding weights, expanding the basket, or incorporating additional newer items.

4.4 Interpreting the OSRS CPI

The resulting CPI for the basket constructed in section 4.3 is shown in figure 3. The CPI is based to the 1st of April 2015. This is due to the fact that the volumes and data availability for the first months of GE, namely February and March of 2015 are inconsistent. This can be seen as the clear spike before April.

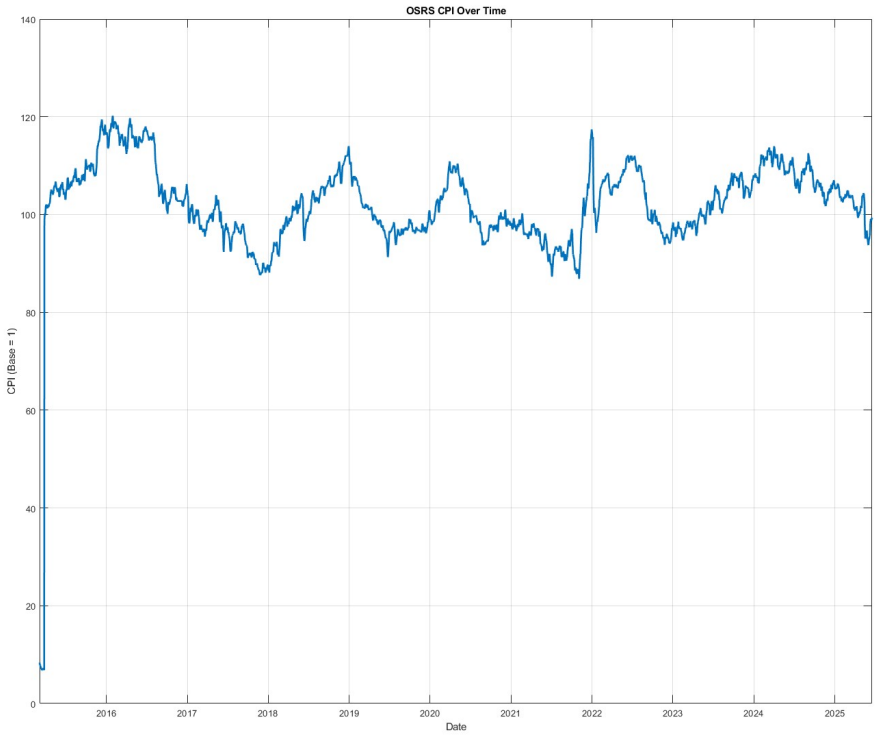

Figure 3: OSRS CPI over time. The index is based to 100 on 1st of April 2015.

The OSRS CPI provides a quantifiable measure of in-game inflation across a broad timespan. The CPI was constructed using a weighted basket of items across four key economic categories: consumables, equipment, skilling resources, and utility items. The basket was carefully selected to include items with uninterrupted historical data since the introduction of the Grand Exchange, ensuring consistency across time. The exact weights are discussed in Section 4.3.

4.4.1 General Trends.

The CPI indicates periods of both inflation and deflation, reflecting complex shifts in the game's virtual economy. Overall, the CPI seems controlled without any signs of major inflation. Between 2015 and 2021, the general trend was upward, with the CPI growing cumulatively and peaking in 2021. During this period, the in-game money supply grew significantly due to high GP-yielding activities and gold farming. This

growth aligns with macroeconomic predictions under the Quantity Theory of Money, where increases in money supply without proportional increases in output result in higher prices. After the GE tax launch in December 2021 the CPI volatility seems to be lesser.

4.4.2 Recent Deflationary Pressure.

From 2022 to 2025, the economy experienced deflationary pressure. In 2022 alone, the CPI declined by over 16%. Possible explanations include the cumulative effect of Jagex's gold sink policies, the introduction of the Grand Exchange tax at the end of 2021, and increased item supply from content updates that diluted demand for older equipment. The overall CPI fell again in 2025 by nearly 6%, suggesting continued price contraction across the average player's consumption basket. Additionally, the effect of the GE tax increase in May of 2025 begins to emerge right at the end of the graph.

4.4.3 Year-over-Year Inflation.

Annual inflation rates further reflect the cyclical nature of the OSRS economy:

- **2021:** Inflation of +19.1%—likely tied to increased player activity due to the pandemic and to the increased gold farming by Venezuelan players [21].
- **2022:** Deflation of -16.1% most likely due to the introduction of GE tax.
- **2023:** Return to moderate inflation at +9.5%.
- **2024:** Mild deflation at -1.9%.
- **2025 Year-to date(YTD):** Decline continues at -5.8%.

These shifts mirror real-world inflation patterns tied to monetary policy, supply-side constraints, and market psychology. The case of OSRS shows that virtual economies, though centrally managed, are not immune to systemic inflationary and deflationary trends.

4.4.4 Comparison Without Weights

For comparison the CPI result without category weights is introduced in Figure 4. It can be observed that the weights have only a minor impact on the result. This is most likely due to the fact that there are many items in the basket which causes the weights to item specific weights to be similar in the end.

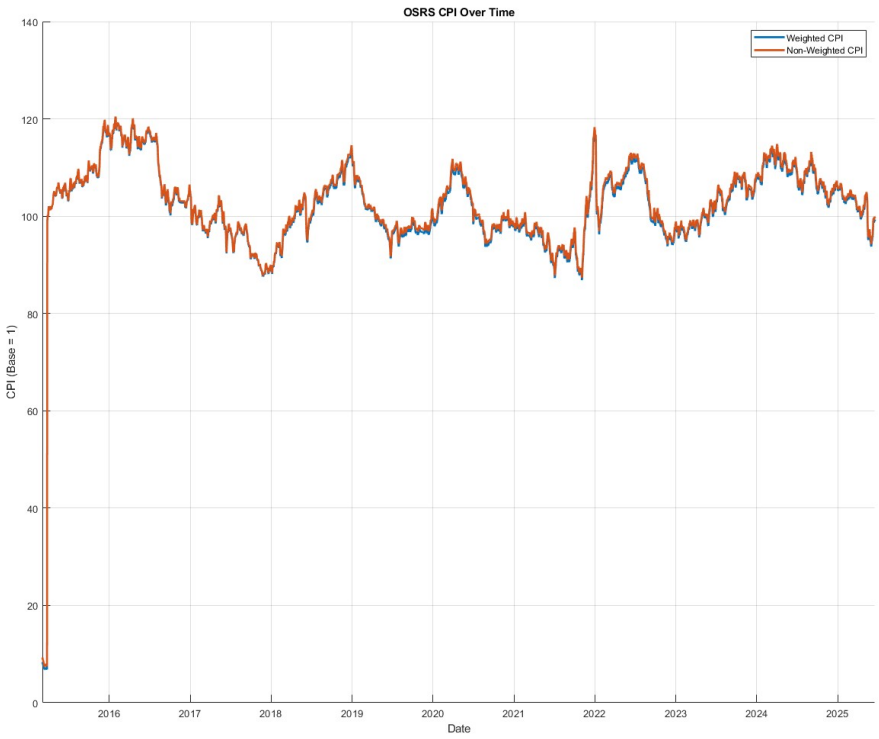

Figure 4: CPI without item category weights and with the weights. Orange indicating the non-weighted CPI and Blue the original weighted CPI.

4.4.5 Conclusion.

The OSRS CPI behaves in a manner broadly consistent with macroeconomic theory. Because of this a critical evaluation of the basket is necessary as the common consensus among the players and game developer Jagex is that the price levels are rising. For further evaluation, newer items should be added to the basket. Since the average player

is now in the endgame phase, the basket should also include more high-tier items than it currently does. For this reason one item that links real-world and OSRS, Old School RuneScape Bond, is studied in section 4.5.

Overall, it can be observed that player behavior, developer interventions, and structural game changes interact to produce observable macroeconomic outcomes. In the sense of traditional CPI the inflation has been controlled within the game. This supports the hypothesis that virtual economies can act as useful experimental platforms for exploring inflation, monetary design, and policy effectiveness.

4.5 Bond Price Trends and Real-World Relevance

In addition to general price levels captured by the OSRS CPI, the price of the bond in the game offers a unique window into the intersection of virtual and real-world economies. The bond is an item that can be purchased with real money and traded in-game for gold pieces (GP) [6], effectively setting an exchange rate between fiat currency and virtual currency. The bond can then be used to gain 14 days of membership. Bonds are sold by Jagex and are the only legitimate way to convert real-world money to in-game GP. While the bond system is the only legitimate way to convert real money into GP, gold farming and third-party RWT markets create an informal reverse channel. Players may sell in-game gold for real currency outside official systems but by doing that they risk getting banned from the game. The original price of bond was $5.99 when introduced to the game, but the price has been increased twice. First in 2022 to $7.99 and then in 2024 to $8.99. This will also have an effect for the in-game price as the bonds are therefore more valuable. The bond price index shown in Figure 5 shows a clear upward trajectory over time, indicating significant inflation in the cost of bonds measured in GP. This 900% inflation cannot be only explained by the $4 price increase of bonds, especially considering the real-life inflation. This suggests that the in-game value of real money has increased relative to GP, meaning players must now spend more virtual currency to access the same premium benefits. This indicates that the value of GP has inflated. Such inflation is driven by both supply-side constraints,

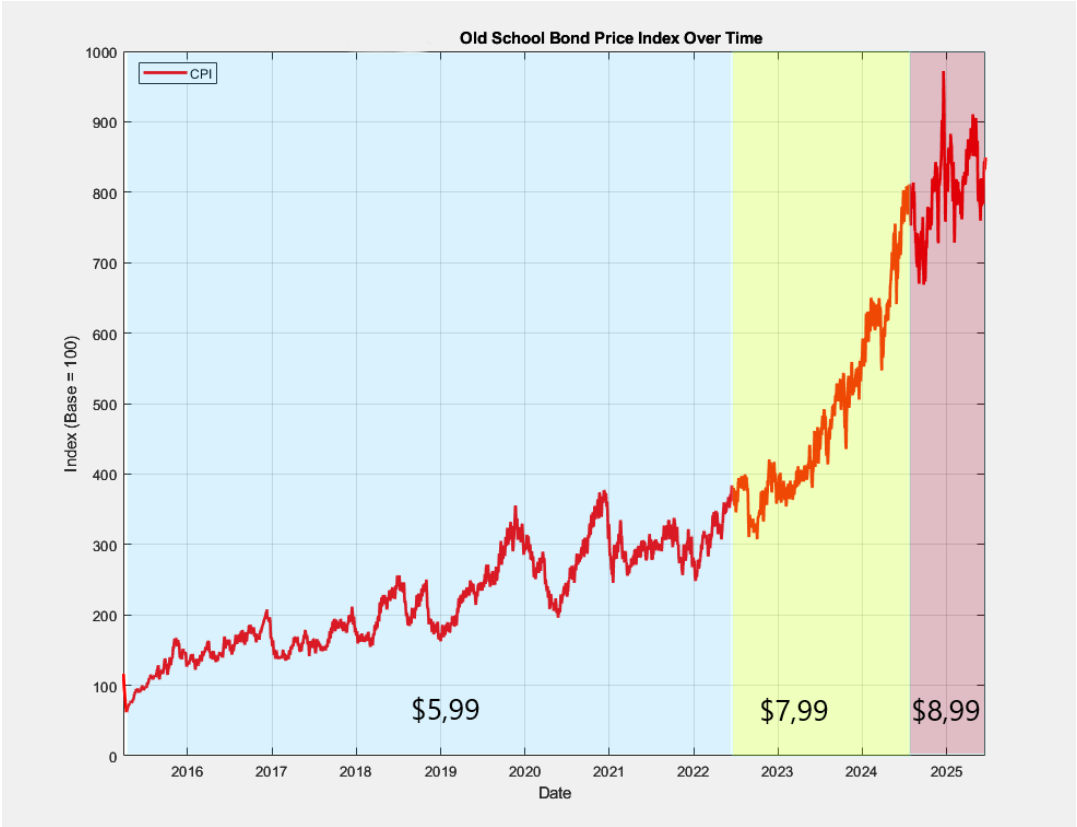

Figure 5: Bond price in GP over time (indexed to 100 on 1st April 2015). Color zones visualize the current bond price in USD. The graph shows how the exchange rate between real-world currency (USD) and in-game GP has evolved, reflecting inflationary trends.

limited availability of bonds and increasing demand from players who use bonds to finance membership. Additionally, the rising amount of GP causes the bond prices to increase.

The introduction of GE tax can be seen at the end of 2021, which clearly stabilizes the inflation for some time but the effect is then canceled by the increased prices of bond in May of 2022. Similar effect can be seen when the GE tax is increased to 2% in May of 2025.

These observations reflect on the nominal exchange rate, not accounting for the inflation of the USD. Between 2015 and 2025 the USD has also inflated on average 3,09% per year which cumulates to 35,63 % [22]. The inflation of the USD needs to be

considered if evaluating the real exchange rate changes between OSRS GP and USD.

This trend is not merely cosmetic. Because bonds can be bought with real currency and sold for GP, they establish a quasi-exchange rate between OSRS and real economies. Consequently, inflation in bond prices reflects a form of currency devaluation within the game. This is economically relevant because it ties the value of in-game effort (GP) to real-world labor or capital. The phenomenon closely parallels inflationary dynamics in real economies, where foreign exchange rates and central bank policy influence domestic purchasing power.

The relevance of bond inflation extends further when considering RWT. High in-game bond prices may incentivize illicit gold farming, as the return on GP in terms of fiat currency rises. This feedback loop reinforces the importance of Jagex's monetary controls and gold sinks as tools to stabilize the in-game economy and mitigate inflationary risk.

Overall, the bond market acts as a bridge between OSRS's virtual economy and real-world macroeconomics. Monitoring its inflation trend not only informs virtual price stability but also highlights the permeability between digital and physical marketplaces.

5 Macroeconomic Model Analysis

This section evaluates how the macroeconomics models discussed in Section 2.1 are applicable to Old School RuneScape (OSRS). There will be evaluation in how capable are the models in explaining observed inflation dynamics and monetary actions by Jagex. Although OSRS is a synthetic environment, earlier sections have demonstrated that it shows coherent economic behavior. Specifically, price level fluctuations, gold supply changes, and developer interventions create conditions comparable to those encountered in real-world macroeconomic systems.

The models discussed in the section are the Quantity Theory of Money (QTM), the Aggregate Supply–Aggregate Demand (AS–AD) framework, and the central bank monetary policies with Jagex acting as the monetary authority. Each model is applied to empirical patterns observed in OSRS from 2015 to 2025 with the constructed CPI from Section 4.4, including periods of high inflation, deflationary correction, and update-driven price volatility.

This section analyzes these models to assess their explanatory power and identify theoretical limitations within virtual contexts. It also discusses how these models should be adapted when applied to virtual economies similar to OSRS.

5.1 Quantity Theory of Money and OSRS

The Quantity Theory of Money (QTM), introduced in Section 2.1.2, provides a useful analytical tool for interpreting the inflationary dynamics within the OSRS economy. While it was originally developed to describe real-world monetary systems, QTM has also previously found applications in synthetic economies due to its structural simplicity and predictive implications [1, 2].

In the case of OSRS, the core assumption of QTM, an increasing money supply M with relatively fixed real output Y appears to hold. As previously described, gold pieces (GP) are generated through in-game activities such as monster drops and skilling with no upper bound. However, item production is constrained by in-game mechanics and more high-level items becoming desirable, which limits growth in Y. This imbalance

can be also seen in the CPI trends discussed in Section 4.4, where prolonged periods of inflation correspond to times of GP generation without enough restrictions, aligning with QTM predictions.

Furthermore, the implementation of monetary controls by Jagex, such as the Grand Exchange (GE) tax and other gold sinks, has demonstrated effectiveness in fighting the inflation within the game. The sharp deflation observed after 2021 when the GE tax was introduced shows that reducing M growth stabilizes price levels, again consistent with the QTM framework.

Nevertheless, the theory has limitations when applied to a virtual setting. Firstly, the assumption of stable velocity V may not always hold. Game updates, speculative trading, and botting can significantly alter transaction frequencies, introducing volatility unaccounted for by QTM. Secondly, behavioral dynamics such as hoarding, flipping, and update-driven speculation play a substantial role in short-run price fluctuations and wealth concentration. There factors are better captured by models incorporating expectations or microfoundations.

In summary, while the QTM captures broad inflationary trends in OSRS, especially over longer time horizons, its predictive power diminishes in contexts influenced by behavioral shocks, design changes, and liquidity events. It is thus best understood as a simple approximation and is benefits from complementary models.

5.2 AS–AD and Update Effects

The Aggregate Supply–Aggregate Demand (AS–AD) model, introduced in Section 2.1.3, provides a framework for analyzing how macroeconomic shocks affect both output and price levels. In the context of OSRS, this framework is especially relevant for modeling the impact of game updates and developer interventions, which can be compared to real-world supply and demand shocks [9, 10]. To complete the AS–AD model, the supply side can be understood through an adapted Phillips Curve logic, where shifts in GP income potential alter player behavior similar to wage dynamics in real economies.

The pattern in OSRS inflation discussed in Section 4.4 showcase the effect of major game updates on price dynamics. On the demand side, the release of new bosses or high-level content frequently raises the demand for specific items, creating rightward shifts in the AD curve. These are not so visible in the inflation. Such events result in short-term price surges across related market segments, as observed during the release of Theatre of Blood and Tombs of Amascut [6]. These can be interpreted as demand shocks in the AS–AD framework.

On the other side, supply shocks are triggered when updates introduce new item sources or increase drop rates. For example, when a boss is added with a high chance of dropping specific gear or consumables, the in-game supply of those items expands rapidly. This can lead to significant downward pressure on prices—reflected as rightward shifts in the short-run aggregate supply curve. Such effects were visible following updates that rebalanced drop tables or introduced duplicate content across multiple bosses [6].

The observed CPI deflation times in 2022–2025 are in line with several key supply-side changes, including higher output of commonly traded resources and adjustments to gold farming viability. These supply shocks interacted with gold sink policies to reduce aggregate price levels. The result is consistent with downward-sloping AD intersecting a right-shifted short-run aggregate supply curve.

Importantly, the AS–AD model helps explaining the dual nature of OSRS economic shocks: price and quantity changes occur simultaneously, mediated by player expectations and update anticipation. For instance, speculative behavior before major patches like item hoarding or panic selling contributes to heightened volatility and price overshooting. These dynamics cannot be fully explained by QTM alone and highlight the strength of the AS–AD approach in modeling transitional responses and short-run disequilibria.

In conclusion, the AS–AD framework captures the multi-dimensional effects of developer updates on the OSRS economy. It complements the longer-term trends identified through QTM by modeling the immediate and often temporary disruptions caused by content changes, behavioral responses, and policy announcements.

5.3 Jagex as Central Bank

Although Old School RuneScape (OSRS) does not have a formal monetary authority, Jagex can be seen in the role of a central bank through its control over the money supply and in-game inflation mechanisms. Differing from traditional institutions like the European Central Bank or the Federal Reserve, Jagex exercises monetary power through game mechanics. These mainly include the design of gold sinks, and the Grand Exchange (GE) tax [3, 6, 7].

Jagex's interventions can be categorized as implicit monetary policy tools. For example, the introduction of the GE tax in December 2021, and its subsequent increase to 2% in May 2025, mirrors contractionary monetary policy. These measures reduce the effective money supply M by taxing transactions and removing gold from circulation. Similarly, the implementation of high-cost activities for example construction skill training, item repair, and death costs, functions similarly to fiscal drains, discouraging hoarding and easing the inflationary pressure.

Even though Jagex does not have a stated inflation target, it shows behavior comparable to central banking goals. It seem to drive for maintained price stability, ensuring liquidity, and responding to external economic shocks. For instance, gold farming spikes during the COVID-19 pandemic led to accelerated inflation, which was countered through policy changes, such as sink expansions and resource rebalancing [6]. These actions imply that Jagex might be operating within an rule-based framework like a Taylor Rule [16].

As a speculation controlled increase in the general price level can be economically beneficial for Jagex, as GP loses value, players must pay more for membership bonds in-game, increasing the likelihood of real-money purchases. This mirrors the role of inflation in real-world economies, where moderate inflation can stimulate spending and economic activity. However, from the player's perspective, rising prices without a corresponding increase in income in other words GP earned per hour, effectively reduces their real wage. If the perceived value of gameplay lowers, players may become discouraged, potentially resulting in lower engagement or even players quitting the

game. Thus, Jagex must balance the benefits of inflation-driven monetization against the risk of degrading the user experience. Ultimately, their goal is to keep to players happy to gain revenue through the monthly subscriptions and sold OSRS bonds.

Notwithstanding, Jagex differs from real-world central banks in several key aspects. It does not use interest rates or credit instruments, and its interventions are typically implemented through content updates rather than market operations. Moreover, decision-making is not very transparent, with no commitment mechanisms, policy forecasts, or institutional accountability which limits the predictability and credibility of its economic governance [12].

In conclusion, as a monetary authority in a synthetic economy, Jagex performs essential stabilization functions for the game to strive. Its role highlights how centralized control over virtual currencies can produce coherent economic outcomes, especially when done by persistent policy instruments like transaction taxes and item sinks. These findings highlight the relevance of central banking analogies in virtual environments and could offer a sandbox for exploring institutional design and rule-based macroeconomic management.

6 Discussion and Conclusion

This thesis studied the macroeconomic behavior of the virtual economy in Old School RuneScape (OSRS) through the lens of theoretical models especially through constructing Consumer Price Index (CPI). The findings demonstrate that despite being a game, OSRS's exhibits many of the characteristics observed in real-world economies: inflationary cycles, supply and demand shocks, and policy-like interventions from a central authority.

The Quantity Theory of Money gives an approximation for long-run price behavior in OSRS. It is particularly useful during periods of sustained gold supply growth. It manages to capture the underlying relationship between money in-flow and aggregate price levels but cannot explain the short-term dynamics where speculation, botting, and patch-related volatility also affect the inflation. In these cases, the Aggregate Supply–Aggregate Demand (AS–AD) model provides a better and supporting framework. It takes into account game update shocks and captures shifts in both supply and demand that reflect changes in player expectations, item availability, and in-game productivity.

Furthermore, Jagex can be seen in a role of a central bank. While OSRS lacks formal monetary institutions, Jagex exercises significant control over the money supply and inflation through the design of gold sinks, transaction taxes, and reward systems. These interventions, though non-transparent and sometimes irregular, produce effects similar to monetary and fiscal policy in real economies. The increase in the Grand Exchange tax and targeted item sinks serve as clear examples of contractionary policy, helping to stabilize inflation during periods of excessive liquidity.

The application of these models illustrates that traditional macroeconomic theory remains useful in synthetic environments when adapted with context-specific constraints. OSRS, with its well-documented economy and active developer intervention, offers a valuable case study in the economics of designed systems. Nonetheless, certain limitations must be acknowledged. Player behavior is not always economically rational, game updates are often motivated by balance and entertainment rather than

policy objectives, and the economy is inherently vulnerable to manipulation by external actors such as bots or real-world traders.

Even with these limitations in mind, the broader implication is clear: OSRS can serve as a productive testing ground for macroeconomic theories and models. OSRS allows the observation of high-frequency economic activity under controlled, observable conditions. Further studies could be conducted on OSRS's virtual economy on topics as real-life effects of the in-game inflation and including new items in the evaluation of inflation.

In conclusion, this thesis shows that the economy of OSRS mirrors many of the dynamics seen in real-world economy. Macroeconomic models such as the Quantity Theory of Money and the AS–AD framework, along with central bank analogies, are not only applicable but useful in interpreting in-game phenomena. These findings suggest that the line between virtual and real economies is not only thin, but also penetrable. Future research may build on this work by applying more detailed behavioral models, using agent-based simulations, or evaluating the inflation in different manner.

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