
How Exchange Rate Fluctuations Affect Agricultural Innovation

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Abstract

Against the backdrop of the deep integration of global agricultural trade, fluctuations of exchange rates have evolved from an external factor into a systemic variable affecting the entire agricultural industry chain. By building an analytical framework around the “whole industry chain and multiple stages,” this essay examines how exchange rate shocks move through agriculture. Using Brazil as a case, it finds that transmission is uneven across the chain. Cost shocks from imported inputs are passed through quite rigidly at the upstream stage, while their effect on the downstream is weaker because of export hedging and unequal bargaining power. The analysis also suggests that exchange rate fluctuations can push agricultural innovation. For China, exchange rate risk should be treated as a strategic opening rather than only a source of pressure. By funding research and developing technological substitutes for traditional technologies, China can strengthen its agricultural resilience. The essay argues that active risk management and industrial upgrading matter for keeping the domestic agricultural market stable in a complex economic environment.

Keywords

exchange rate fluctuations, agricultural innovation, industrial chain, asymmetric transmission, risk management

1. Introduction

With global agricultural trade becoming more integrated, China's agriculture is now closely embedded in the international division of labor. Dependence on agricultural imports such as soybeans and corn remains high, and upstream inputs such as fertilizers and pesticides are also strongly tied to international markets. At the same time, two-way RMB exchange rate movement has become normal. Under external pressures such as geopolitical conflicts and diverging monetary policies, exchange rate fluctuations are no longer just occasional outside shocks. They now affect the whole agricultural industry chain as a systemic variable. This essay therefore asks how exchange rate fluctuations influence each stage of the agricultural industry chain, and what kinds of transmission patterns and differences appear across those stages.

This essay studies the transmission mechanisms and structural effects of exchange rate fluctuations across the agricultural industry chain. It focuses on three stages. At the upstream cost stage, it examines how exchange rate changes alter the cost of imported products such as feed and fertilizers. In the midstream production and processing stage, it considers how exchange rates change the trading conditions of agricultural products and

then affect input choices and the profits of processing enterprises. At the downstream trade and consumption stage, it discusses export competitiveness, import substitution, and the imbalance between these effects.

This is the core structure.

Compablu with previous research, this essay makes three main contributions. First, it proposes an “entire chain - multi-link” analytical framework. Rather than staying at the level of macro trade aggregates, this framework looks into the internal nodes of the industry chain, so different responses at each stage can be identified more clearly. Second, it points to an “asymmetric transmission” mechanism. Upstream pass-through and downstream price pass-through differ in both intensity and speed, while export elasticity and import rigidity exist at the same time. The effects do not move evenly. Third, it brings capital flows and expectation adjustment into the analysis, expanding the channels through which exchange rates affect agriculture. These points extend the discussion of how agricultural economies operate and provide a basis for agricultural enterprises to manage risk and for policymakers to design more targeted laws.

2. Literature Review

Exchange rate fluctuations have become one of the main external variables affecting both stability and innovation in the agricultural industry chain. This issue is especially relevant at the current stage of Chinese agriculture, where the shift from traditional production to high-value-added and high-tech production is still underway. In that context, industry-chain resilience has become part of the national strategy.

Under this background, systematically exploring how fluctuations of exchange rates affect the innovation of agricultural enterprises in ways such as costs, trade, and capital, whether the mechanism is promotional or inhibitory, and whether there is a difference between different agricultural productions and industry chain stages [1]. It holds not only significant theoretical value but also serves as a reference for policy formulation and innovations of enterprise.

The previous essay provides a multi-dimensional theoretical basis for understanding this issue. First, the Exchange Rate Pass-Through (ERPT) theory holds that fluctuations in the exchange rate are transmitted upstream and downstream along the industry chain through prices, affecting the cost of imported inputs and the prices of exported products [2]. In the agricultural sector, domestic currency appreciation can reduce the cost of imported inputs such as agricultural machinery, seeds and fertilizers, thereby making room for technological upgrading; conversely, domestic currency depreciation may increase import costs and limit technological introduction. Noise trading, trade openness, and delayed exchange rate overshooting.

However, the exchange rate pass-through remains uncertain. The Marshall-Lerner Condition (MLC) states that although domestic currency depreciation makes exported products cheaper and imported products more expensive, only when the sum of the absolute values of the price elasticities of demand for a country's imports and exports is greater than 1 can depreciation truly cut the trade deficit. To examine whether domestic and foreign consumers are highly sensitive to agricultural product prices, the analysis begins with the effects of domestic currency depreciation. After depreciation, foreign consumers may buy more domestic agricultural products for export, while domestic consumers may shift toward less expensive imported agricultural products, which can improve trade conditions [3]. If consumers are not very responsive to price changes, however, depreciation may instead worsen trade conditions [3]. In the short run, import costs can rise quickly. This is the J-curve effect.

Second, Induced Innovation Theory holds that changes in relative factor prices push enterprises to look for substitutes for earlier technologies. When the exchange rate changes, the relative prices of imported inputs also change, and enterprises may adjust by moving from labor-intensive to capital-intensive technologies. Finally, Global Value Chain (GVC) Governance Theory, which pays particular attention to multinational corporations, argues that exchange rate fluctuations affect how firms arrange capital and technology, and this in turn shapes local enterprises' willingness to innovate.

Taken together, these theories suggest that exchange rate fluctuations affect innovation in the agricultural industry chain mainly through transmission mechanisms. [4] Yet earlier research does not point in one clear direction. The disagreement is fairly obvious. Some studies find that exchange rate fluctuations support

innovation by changing costs and improving competitiveness. Others argue that such fluctuations increase uncertainty and decrease firms' willingness to make long-term investments.

The effects also vary across contexts. Different agricultural products, such as land-intensive and labor-intensive products, do not respond in the same way to exchange rate fluctuations. The same is true across different stages of the industry chain. Upstream production and downstream processing face different cost structures, market conditions, and adjustment pressures, so their sensitivity and response mechanisms are likely to differ. Because of this, a more detailed distinction is needed rather than treating the agricultural industry chain as a single whole.

Although previous research has produced measurable results, several limitations remain. First, evidence on the mechanisms affecting enterprises with limited capital is still insufficient. Most studies stay at the macro or industry level and do not closely examine how these enterprises actually respond, so the specific channels through which exchange rate fluctuations operate are still not fully clear. Second, there is still little direct analysis of micro-subject behavior. Earlier work relies mostly on macro data and often overlooks how enterprise heterogeneity, including scale, ownership, and export dependence, may moderate this process.

3. Research Path

3.1 Phase 1: Direct Transmission of price (Import Stage)

When the domestic currency depreciates, the most significant impact is on imports. Take agriculture as an example, products like feed, fertilizers, and pesticides are priced in foreign currencies. A depreciation of the domestic currency means domestic firms must spend more domestic currency to purchase the same foreign goods. Under ideal conditions of “complete pass-through,” import prices would rise proportionately. However, in reality, this increase is often weaker due to market competition.

3.2 Phase 2: Cost-Push and Pricing Games (Production and Processing Stage)

The rising prices of imported ingredients directly increase the production costs for domestic planting and breeding.

One strand of the literature focuses on how price sensitivity shapes trade outcomes. To judge whether domestic and foreign consumers are highly sensitive to agricultural product prices, the key question is what happens after domestic currency depreciation. If foreign consumers respond strongly to price changes, they will buy more domestic agricultural products for export, while domestic consumers will decrease purchases of more expensive imported agricultural products, which improves trade conditions. If price sensitivity is weak, the result may be the opposite, and depreciation may worsen the trade condition [3]. Because import costs often rise quickly after depreciation, this adjustment process is commonly described as the J-curve effect.

A second strand comes from Induced Innovation Theory. Its basic claim is that changes in relative factor prices push enterprises to look for alternatives to existing technologies. Applied here, exchange rate fluctuations change the relative prices of imported inputs, and that pressure may lead enterprises to move from labor-intensive technologies toward capital-intensive ones. The mechanism is fairly direct.

A third strand is the Global Value Chain (GVC) Governance Theory. This view pays more attention to multinational corporations and the organization of production across borders. Sunk costs matter here as well. As long as prices still cover variable costs, firms often continue production instead of exiting the market or sharply increasing prices.

3.3 Phase 3: Chain Diffusion and Final Consumption (Consumption Stage)

As costs rise, the economic pressure moves step by step along the chain. If enterprises at each stage choose to pass costs forward, the pressure builds up and may eventually push food prices in the consumer market to a level that households can clearly feel, which then affects the overall Consumer Price Index (CPI). Even so, this transmission is usually not immediate. Consumers often take time to notice changes after import prices rise

3.4 Phase 4: Non-linear Intervention of Exchange Rate Expectations

Beyond the linear cost transmission described above, market expectations also influence transmission. If expectations of the domestic currency continually depreciating become popular, exporters might adjust their prices in advance to ensure future profits. This can even lead to non-linear, strange phenomena, such as “export prices fall when the currency appreciates, and rise when it depreciates.” This pricing behavior shows the complexity and uncertainty of exchange rate pass-through [5].

4. The Brazil Case Study

4.1 Devaluation of the Real — Rising Costs of primary production(Full Pass-through)

The first stage in exchange rate pass-through begins with Brazil's deep reliance on global supply chains. Despite being a typical agricultural country, Brazil is fully dependent on imports for essential production (fertilizers and pesticides), and the upstream supply side has long been monopolized by international oligopolies.

Under this market structure, exchange rate pass-through exhibits a “complete pass-through” characteristic. When the Real depreciates sharply against the dollar, Brazilian importers and farmers will be forbidden to bargain. This is because inputs like fertilizers are strictly priced in dollars, and there are no cost-effective alternatives. This directly leads to a surge in imported costs. During cycles of Real depreciation, the import cost of fertilizers in Brazil spiked by 42%. Although pesticide prices were more reasonable due to the dollar pricing, the actual expenditure in local currency still surged by 15%-20%. This rigid upstream transmission can be explained by the fact that international oligopolies control the currency fluctuations of Brazilian primary producers at no cost through the exchange rate. The lack of international pricing rights and the rigidity of imported goods jointly lead to rapidly rising production costs.

4.2 Primary Production to Midstream Industry (Incomplete Pass-through)

Faced with the complete pass-through of upstream costs, the Brazilian agricultural production stage avoided losses primarily due to hedging capabilities enabled by its unique export-oriented industrial structure. Brazil's main crops, such as soybeans and corn, are important goods in the international market, which are priced in US dollars. The depreciation of the Real not only raised the cost of imported fertilizers but also directly increased farmers' incomes when their agricultural products were priced in Reals. This hedging mechanism, in which rising import costs and export revenues coexist, provided reliable protection for farmers.

More importantly, the diversion of measures becomes more noticeable. Since currency depreciation greatly enhanced the competitiveness of Brazilian agricultural products in international markets, The profits from this export allowed farmers to maintain cash flow and profits, even in the face of immense production costs. If the products were solely for domestic markets, without the hedge of export profits, producers would inevitably and proportionately pass upstream costs onto the downstream domestic sector, thereby triggering anxiety about product prices.

4.3 Midstream Industry to Retailers and Distributors

Despite immense pressure on upstream costs, exchange rate fluctuations were not fully passed through to Brazil's consumer market. This is a typical phenomenon called “incomplete exchange rate pass-through. “The core logic lies in the difference in bargaining power between upstream and downstream in the industrial chain, which leads to incomplete price pass-through to consumers. The transmission chain from production to the terminal end, midstream processors and retailers purchase products from primary producers. Against the backdrop of Real depreciation and passively higher production costs, midstream enterprises that control logistics, warehousing, and sales channels typically maintain purchase prices unchanged, thereby suppressing acquisition costs and increasing profits.

This asymmetry in bargaining rights results in a speed bump of cost transmission: The danger of upstream price increases is collectively defused by midstream price-suppression measures and profits from the export

market. Ultimately, the price in the consumption market grows much lower. The price inflation consumers experience is far lower than the actual surge in production costs from farmers.

4.4 Structural Implications

From a macro perspective, the case of Brazil clearly illustrates the modifying effect of inflationary environments on exchange rate pass-through. In developing countries, when inflation is high, consumers are relatively less price-sensitive, making it easier for enterprises to pass on costs and, thus, the exchange rate pass-through is more successful. In a relatively stable environment, however, enterprises tend to accept some of the costs to retain market share [6].

The effect of the Real's depreciation on Brazil's agricultural industrial chain is therefore uneven. It works through “rigid upstream input, midstream bargaining, and export hedging.” For policymakers, the key issue is this incomplete pass-through mechanism. If they rely only on currency depreciation to boost exports, it may bring short-term gains, but over time it can put pressure on domestic midstream and downstream industries, reduce farmers' real income, and add structural risks linked to imported inflation [7].

5. The Feasibility of the Brazil Case for China's Agricultural Innovation

5.1 Upstream of the Industrial Chain: From Passively Accepting Costs to Forcing the Substitution and Autonomy of Former Tech

China also depends on imports for high-end agricultural machinery, quality seed sources, and agricultural inputs. Under these conditions, exchange rate fluctuations can create pressure, but they can also push domestic independent innovation.

When imported fertilizers and pesticides become more expensive because of exchange rate fluctuations, domestic producers are more likely to turn to lower-cost domestic substitutes. This creates direct pressure for local producers to improve product quality and technology. The upstream industrial chain then has a clearer incentive to blueuce dependence on expensive imported inputs and move toward domestic alternatives. Exchange rate depreciation also makes imported high-end large-scale machinery far more expensive and raises maintenance costs. In response, research institutions and related enterprises may increase efforts to develop lightweight and simplified agricultural equipment better suited to China's terrain, easier to operate, and easier to maintain, which helps build a more independent agricultural equipment supply system.

5.2 Midstream of the Supply Chain: Using Export Profits to Feed Back into the Technological Iteration

China has a clear advantage in exporting agricultural products such as vegetables, fruits, aquatic products and tea. A moderate depreciation of the RMB can bring more cash flow to China's export-oriented agricultural enterprises. On that basis, relevant policies should guide these enterprises to innovate, upgrade original storage and cold-chain systems, and purchase intelligent equipment, so that production moves from traditional agriculture toward more technology-intensive agriculture.

Exchange rate uncertainty also puts pressure on enterprise management. Large agricultural enterprises should strengthen digital transformation, especially in pricing and risk control. With big data, firms can monitor international products' prices in real time and make more accurate calculations. This kind of management adjustment, shaped by external risk, can improve risk management and strengthen the coordination of China's domestic agricultural industrial chain [8].

5.3 Downstream of the Supply Chain: Optimizing Bargaining Mechanisms to Weaken Rigid Transmission of Costs to Consumption

Given the advantage of a massive domestic market, China should blueuce risk for farmers and midstream processors by improving agricultural futures and insurance tools. The role of the large market matters here. When exchange rates raise imported costs, large-scale domestic supermarkets, e-commerce platforms, and deep-processing enterprises should use their channel advantages in negotiation and price regulation. If supply

chain efficiency improves, part of the added cost can be absorbed within the chain rather than being passed directly to consumers. This would help stabilize the domestic agricultural market while maintaining sufficient profits for farmers.

5.4 Macro Management: Coping with Exchange Rate Risks through “Management Innovation” to Enhance Supply Chain Resilience

Exchange rate risk is now a major factor in the agricultural supply chain. [9] As RMB internationalization continues, domestic agricultural enterprises are likely to use RMB more often in trade with “Belt and Road” countries and other international trade partners. A change in settlement models of this kind could improve the ability of the agricultural supply chain to respond to risk. It could also strengthen the resilience of agricultural enterprises when they face external financial shocks.

From an economic perspective, the similarity between the Brazil case and China's practice lies in the “asymmetry of exchange rate pass-through.” In the agricultural industrial chain, upstream inputs often have low price elasticity, which makes cost pass-through easier to carry out.

It would limit the consumption of agricultural products, making the cost pass-through to the terminal end really hard. It is called “J-Curve Effect”: In the early stages of exchange rate fluctuations, due to time lags in adjusting import/export volumes, the trade deficit may initially worsen the agricultural trade and corporate profits. However, as time passes, with domestic agricultural enterprises pursuing technological innovation model innovation, and market adjustments, the trade balance and profits will gradually surpass previous levels.

Therefore, when facing exchange rate fluctuations, policies should not merely focus on short-term price stability. Instead, they should invest their time in agricultural innovation and financial infrastructure, helping enterprises in the supply chain return to profitability as quickly as possible and pursue high-quality development [10].

6. Conclusion

This study examines how exchange rate fluctuations are transmitted to the innovation of agricultural new quality productive forces through a “whole industry chain” analytical framework. Using Brazil as the case, it identifies an “asymmetric transmission” pattern. Exchange rate shocks show a “complete pass-through” in the upstream sector because of import rigidity, while the effect on the downstream sector is much weaker because export hedging and uneven bargaining power limit transmission.

One main finding is that exchange rate fluctuations may work as a “catalyst” for innovation. When the currency depreciates, rising costs push firms to replace some technologies and reduce reliance on imported inputs, moving instead toward autonomous technological research. At the same time, export profits during depreciation cycles can give agricultural enterprises more capital to invest in high-tech equipment and digital transformation.

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Conflicts of Interest

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