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Brazil's Agricultural Competitiveness: Recent Growth and Future Impacts Under Currency Depreciation and Changing Macroeconomic Conditions

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Abstract

Macroeconomic reforms and policies have contributed to Brazil's emergence as one of the world's most competitive agricultural exporters. Brazil's agricultural sector increased its exports in recent years, despite experiencing one of its worst recessions during 2014-16, falling international commodity prices, and slower demand growth in China and other foreign markets. To understand the forces behind this development, this report examines the effects of changing macroeconomic conditions on Brazil's agricultural production and trade by simulating impacts of accelerated depreciation of its exchange rate and sustained macroeconomic growth. When the Brazilian currency weakens, higher prices in local currency stimulate production and exports of most major commodities. Simulations show that depreciation of Brazil's currency results in greater world supplies, lower prices in global markets, and increased competition for U.S. exports. Finally, a simulation of stronger Brazilian economic growth shows that an increase in domestic consumption would have reduced Brazil's exports of beef, corn, cotton, ethanol, pork, and soybean meal, easing downward pressure on world prices. However, Brazil's soybean exports would not have been significantly affected by stronger economic growth.

Keywords: Brazil, agriculture, production, trade, recession, exchange rate, devaluation, credit, interest rates, domestic support.

Acknowledgments

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Contents

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A report summary from the Economic Research Service September 2020

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What Is the Issue?

Brazil's macroeconomic policies have played an important role in its emergence as one of the top exporters of agricultural products, including soybeans, corn, cotton, sugar, coffee, orange juice, and meat. However, extended periods of currency depreciation, low energy costs and interest rates, rising demand for biofuel feedstocks, and macroeconomic fluctuations have contributed to Brazil's emergence as a competitor for the United States in global agricultural markets. This study explores the role of macroeconomic variables by simulating the impact of Brazilian policy-driven currency depreciation and sustained macroeconomic growth on Brazilian agricultural output and trade. The potential impact of macroeconomic events on Brazil's agricultural exports remains important, especially as the country's economy and agricultural commodity markets are vulnerable to the effects of the COVID-19 pandemic.

What Did the Study Find?

A weaker value of Brazil's currency, the *real* (denoted as BRL), during its deep 2014-16 recession contributed to the record growth in Brazil's agricultural exports. During 2014-16, devaluation of the Brazilian currency encouraged Brazil's farmers to bring more new land into production and increase double-cropping. Consequently, local currency-denominated prices yielded increased net returns for Brazilian farmers despite weak dollar-denominated prices in global markets. The expansion of Brazil's land use was led by a 20-percent growth in the soybean area. USDA has projected additional growth in production and exports to 2028, and simulations show that this growth could accelerate if Brazil's currency weakens more than previously expected. Alternatively, stronger economic growth in Brazil could stimulate more domestic meat consumption with more domestic use of corn and soybean meal.

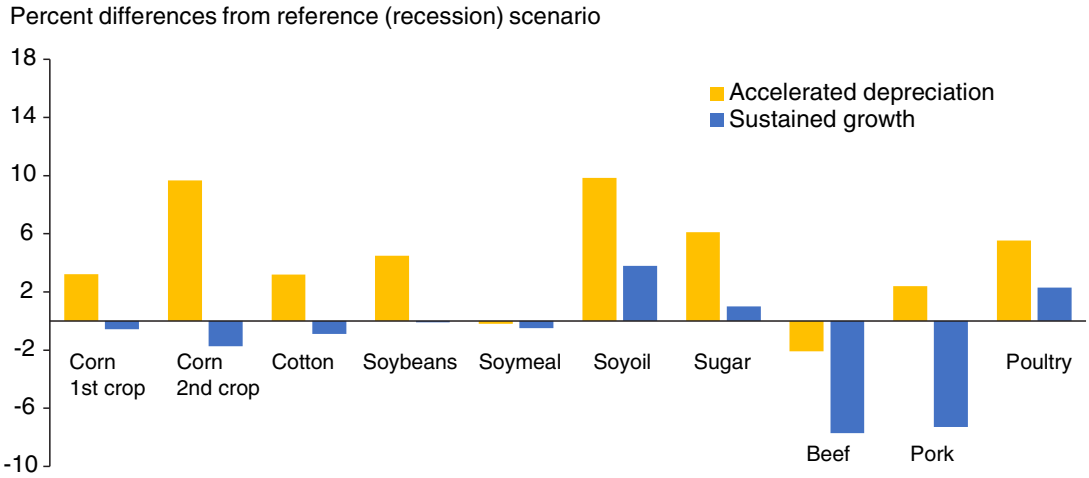
Key findings from two simulated macroeconomic scenarios (accelerated depreciation and sustained growth) show:

- Faster depreciation of the *real* could lead to even faster growth in Brazilian exports than projected in USDA's 10-year projections. Simulations show that Brazil's exports of each major commodity could be an aggregate 5.6 percent greater and international prices 2.7 percent lower by 2028, compared with the USDA projections released in February 2020.

- Changes in net returns would divert cropland from sugarcane to soybeans and corn, yet a reduction in fuel imports would induce greater use of sugarcane to produce ethanol.
- Faster economic growth in Brazil would reduce its exports of beef and pork as more meat is consumed domestically, narrowing the gap between red meats and chicken prices. Increased poultry exports, driven by the price competitiveness of the Brazilian product, reflect Brazil's status as the world's largest exporter of chicken meat. More Brazilian corn would be used as animal feed and more soybeans would be processed to feed livestock. Corn exports would fall marginally, but soybean exports would not change substantially.
- During the 2020 COVID-19 pandemic, Brazil's currency depreciated further, and its economy slowed. Experience and simulation results suggest that these developments could spur Brazil's agricultural export growth. However, Brazil's export performance also depends on the pandemic's impact on demand in importing countries.

These changes are summarized in the following chart:

Change in Brazil's average exports in 2019-28 under alternate scenarios



Source: USDA, Economic Research Service research results.

How Was the Study Conducted?

The study simulated impacts of macroeconomic scenarios with a partial equilibrium model of Brazilian agriculture that is used to generate USDA's long-term baseline projections for production and trade over 10 years. The model includes assumptions for key macroeconomic variables (e.g., income growth, interest rates, and exchange rates), petroleum and fertilizer nutrient prices, producer and trade policies, and production technology. The first scenario assumes the BRL depreciates against the U.S. dollar at a faster rate than is assumed in the USDA reference baseline during the 2019-28 projection period (accelerated depreciation scenario). A second scenario assumes that Brazil was able to sustain economic growth on the trend established before 2014 and retained that growth through its recession years (2014-16) and in future years (2019-28) (sustained growth scenario). The results of these simulated projections are compared with the baseline projections to 2028 to assess the impact of each scenario on Brazil's supply and demand for grains, oilseeds and products, cotton, livestock products, sugarcane, sugar, and ethanol. Effects on global markets were measured by combining the model with 41 other country/regional models in the Country-Commodity Linked System to generate global commodity supply, demand, trade, and equilibrium prices for 2014-28.

Brazil's Agricultural Competitiveness: Recent Growth and Future Impacts Under Currency Depreciation and Changing Macroeconomic Conditions

Introduction

Brazil has made a remarkable transformation from being an exporter of tropical agricultural products such as coffee, sugar, and cacao in the 1960s and 1970s to becoming a major global supplier of soybeans, corn, cotton, sugar, coffee, orange juice, and meat since the early 21st century. Brazil is now an important agricultural competitor of the United States in international markets for many of these commodities. With abundant cropland and pasture, its standing as the world's ninth-largest economy and the largest recipient of foreign direct investment flows in Latin America along with a population of 208 million growing 1 percent annually, Brazil is likely to continue playing an important role in global agricultural trade (World Bank, 2020).

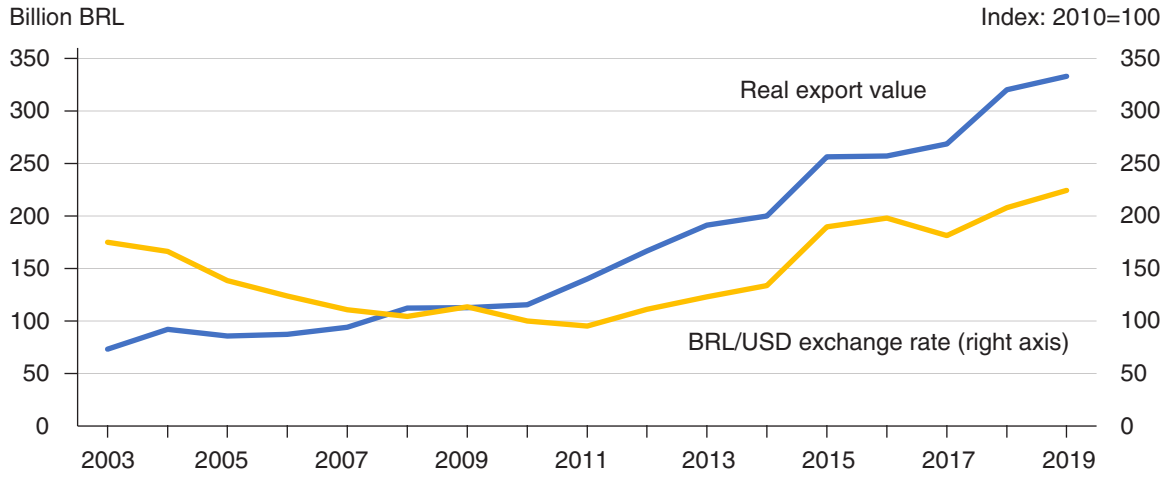
Brazilian agricultural value added grew an average of 3.4 percent annually over the past two decades, with agricultural output doubling and livestock production increasing threefold (IBGE, 2020). At the same time, Brazil emerged as an important exporter to international grain, oilseed, and meat export markets, and competitor of the United States. Brazil's agricultural exports, including processed products, have grown 12 percent per year since 2000 and account for 37 percent of Brazil's total exports (Trade Data Monitor, 2020). Consequently, Brazil is now the world's largest global exporter of soybeans, poultry meat, beef, coffee, sugar, and orange juice, and is the world's third largest exporter of agricultural products behind the European Union (EU) and the United States (Trade Data Monitor, 2020).

Some of the factors driving Brazil's transformation include agricultural research that increased yields, expansion of the arable land base, large investments in production technologies to develop new crop and forage varieties, and increased global demand for food and animal feed, particularly over the last decade (USDA/OCE, 2019). Export-oriented macroeconomic policies, crop-specific agricultural policy incentives, and the growing multinational presence and foreign investment in the country also contributed to the generation of increased agricultural output. (De Gorter et al., 2013; Valdes et al., 2016).

In addition, Brazil's macroeconomic conditions and policies have contributed to its emergence as an exporter. Fluctuations in its exchange rate, economic recessions and expansions, and its domestic demand for commodities, prompting credit, tax, and price policies that influence agriculture, have all played a role in the increased competitiveness of Brazilian agricultural exports. Understanding how macroeconomic conditions affect Brazilian agriculture is important to assess prospects for U.S. agricultural exports considering the size and growth of the Brazilian agricultural sector, its share of world markets, and its effect on global supply chains (USDA/OCE, 2019).

Various studies have examined the links between exchange rate changes, macroeconomic fundamentals (including competitiveness), and the links to trade volumes (Clark et al., 1994; Marsh and Tokarick, 1994; Nie and Taylor, 2015; Wondemu and Potts, 2016). The relationship between exchange rates and agricultural product and factor markets has also been extensively examined (Schuh, 1974; Paarlberg et al., 1994; Gong and Kinnucan 2015). Like many developing countries reliant on exports, Brazil's exchange rate policies have influenced Brazilian agricultural exports. Depreciation of the BRL relative to the U.S. dollar reduces the dollar price of Brazilian products sold in foreign markets, thus promoting export sales. Brazil's emergence as a soybean exporter may be traced to the Asian financial crisis that pushed the country into a recession in 1998. This led to devaluation of the Brazilian BRL in January 1999, followed by a second devaluation in 2001. These devaluations benefited Brazil's export sector by lowering the price of its export products and boosting producers' revenues in domestic currency (Langley, 2000). During this period, area planted to soybeans expanded rapidly, peaking in 2004 (USDA, FAS, 2019c). Another recession and devaluation in 2009 followed the global financial crisis. During subsequent years, large commercial farmers increased production and exports significantly (USDA, FAS 2019b). Brazil's devaluations in 1999, 2001, and 2009 had a positive effect on agricultural trade, contributing to Brazilian agriculture's increasing export-orientation with each recession (fig. 1).

Figure 1
Real export value of all agricultural products and Brazil's BRL-USD exchange rate



Notes: BRL=Brazilian real, USD=U.S. dollar.

Source: USDA, Economic Research Service using data from Trade Data Monitor, 2020 and Banco Central do Brasil, 2019.

Another steep recession that began in mid-2014 and ended in 2016 was the country's worst in decades. It shrank Brazil's gross domestic product (GDP) by 3.6 percent in 2015 and 3.3 percent in 2016. The Brazilian economy started its recovery in 2017-18, with GDP growth of 1.3 percent, subsequently falling to a 2019 GDP growth forecast of 1.1 percent (Oxford Economics, 2020). Growth in farm output was helped by increased rural credit subsidies issued by Brazil's government to offset shrinking private credit and maintain production incentives and profitability during the decline in international commodity markets that preceded the recession (Banco Central do Brasil, 2019).

Despite adverse economic conditions, production increases and productivity gains during the 2014-16 recession allowed the Brazilian agricultural sector to contribute to GDP growth. Through its stimulation of farm-related industries like fertilizer and machinery, the agriculture sector was a catalyst for reviving the economy and as a counterbalance to the contraction of the industrial and service sectors. Rising foreign investment in crop production, fertilizer compounding, and technology dissemination also drove yield growth. These developments contributed to further agricultural productivity increases and higher levels of agricultural output, which then increased the sector's ability to grasp export opportunities presented by the rising demand for feedstuffs in China and, to a lesser extent, other foreign markets. The increasing efficiency of Brazilian agriculture paired with devaluation of the BRL relative to other currencies further contributed to the growth in Brazil's agricultural exports. This combination of circumstances helped to restore balance to the economy and allowed the agricultural sector to withstand many of the recession's negative effects.

This study examines the impact of two different macroeconomic scenarios on future Brazilian agricultural productivity. This report uses the U.S. Department of Agriculture, Economic Research Service's baseline modeling system for world agriculture to examine the effects of changing macroeconomic conditions on agricultural production and trade in Brazil. To show how a further devaluation of the BRL could affect agriculture, an alternative scenario is considered in which the BRL depreciates more rapidly and over a longer period than what happened during the recession. A second counterfactual scenario features sustained GDP growth during the years of Brazil's recession (2014-16) and to 2028 to explore whether economic growth reduces agricultural exports by generating stronger domestic demand for commodities.

Background: Brazil's Macroeconomy and Agriculture

Brazil is one of the most competitive agricultural producers and exporters in the world. A review of its evolution from import-substitution policies to agricultural exporter provides context for understanding Brazil's recent expansion of agriculture and its role in the 2014-16 recession.

During the 1960s and 1970s, Brazil was a large and consistent net exporter of various (mostly tropical) agricultural products. It has become a major exporter of sugar, cotton, and commodities normally exported by temperate-zone countries including corn, soybeans, and meat, because of significant investments in agricultural research and development, abundant land resources, receptivity to foreign investment, and generous support policies. The growth of its agricultural sector proceeded through a series of macroeconomic expansions, contractions, and crises.

The growth of Brazilian agriculture is rooted in the "Green Revolution" development strategy adopted in the mid-1960s that emphasized the use of technologies and farm management practices best suited to tropical latitudes (Caldas et al., 2010). The Brazilian Government provided fiscal and financial support to agriculture during the 1970s and 1980s, including large amounts of subsidized credit (Mendoça et al., 2013). From the mid-1990s onwards, with higher world prices for agricultural commodities, Brazil's sustained agricultural growth has been largely investment-driven, marked by rising foreign investment and increased participation of multinationals in the agriculture and food sectors (Barros, 2009).

The achievements in the 1960s and 1970s that were most significant for agriculture were followed by periods of economic stagnation in the 1980s and early 1990s (Barros, 2009). The early 1990s were characterized by hyperinflation, a result of accumulated fiscal deficits and expansionary monetary policy. In 1994, the government finally managed to control inflation by implementing an exchange-rate-based stabilization policy known as the *Plano Real*. Brazil also liberalized agricultural trade by reducing tariffs, removing quantitative restrictions, and eliminating an import-substitution industrialization (ISI) development strategy during 1988-94 (Pereira et al., 2012). These policies helped Brazil resume rapid growth.

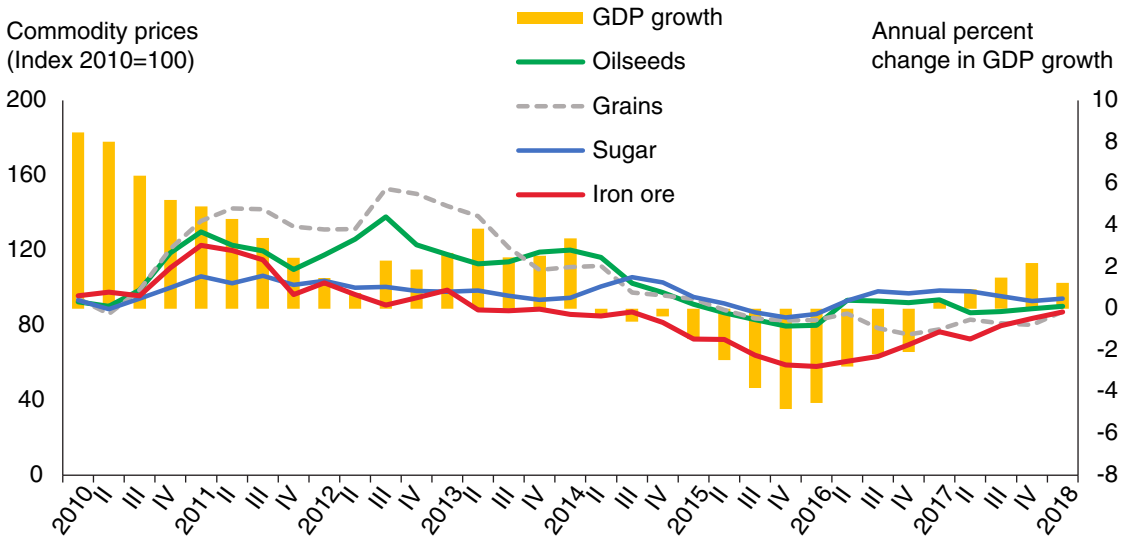
After 1994, macroeconomic reforms, open trade, and flexible exchange rate regimes created an environment that helped its agricultural sector flourish. With a more stable and open economy, Brazil reaped returns from government-sponsored breeding of cultivars and livestock suited to the climate and soil conditions of Brazil's tropical *Cerrados* savannah. By using vast land resources in Brazil's agricultural frontier area in the 1990s, the country became one of the world's top producers of soybeans, corn, cotton, and meat (Gasques et al., 2012).

During the 2000s, the government sought to increase competitiveness in agriculture by reducing production costs, improving market access, and expanding infrastructure. The 2000-03 *"Avança Brasil"* development plan directed government support to agro-food technology and research, as well as animal and plant health protection (Cardoso, 2011).

During the 2004-10 period, the Brazilian economy experienced fast growth driven by rising commodity prices for agricultural exports and low-interest international credit. During this period, expansionary domestic fiscal and monetary policies stimulated demand, while government food subsidy programs also played a significant role (Oxford Economics, 2018). As a result, annual GDP growth averaged 4.5 percent during 2004-10, more than twice the 2-percent growth attained between 1997 and 2003 (World Bank, 2019).

Following this rapid economic growth, the fall in commodity prices in 2011 for some of Brazil's key export commodities (e.g., soybeans, grains, raw sugar, iron ore), led to a slowdown in GDP growth (fig. 2). In 2011, the newly elected Rousseff government implemented several expansionary policies, including government liquidity support to the banking system, a reduction in interest rates, and a substantial expansion of public spending. As a result, the net public sector debt-to-GDP ratio increased from 28 percent in 2004 to 43 percent in 2011 (Banco Central do Brasil, 2019). The vote to impeach President Rousseff in May 2016 was tied to the violation of the fiscal discipline required under the 2000 Fiscal Responsibility Law. These measures led to a moderate and temporary pickup in GDP growth in 2012-13, while contributing to rising inflation and widening fiscal and current account deficits[1] (fig. 3). By 2013, despite indications of an impending recession, the buildup of debt prompted the Brazilian Government to reduce public investment and interest rates and devalue the currency to try to restore macroeconomic credibility, increase private investment, and stimulate export growth (Oxford Economics, 2020).

Figure 2
Brazil's quarterly GDP growth and major export commodity prices, 2010-18



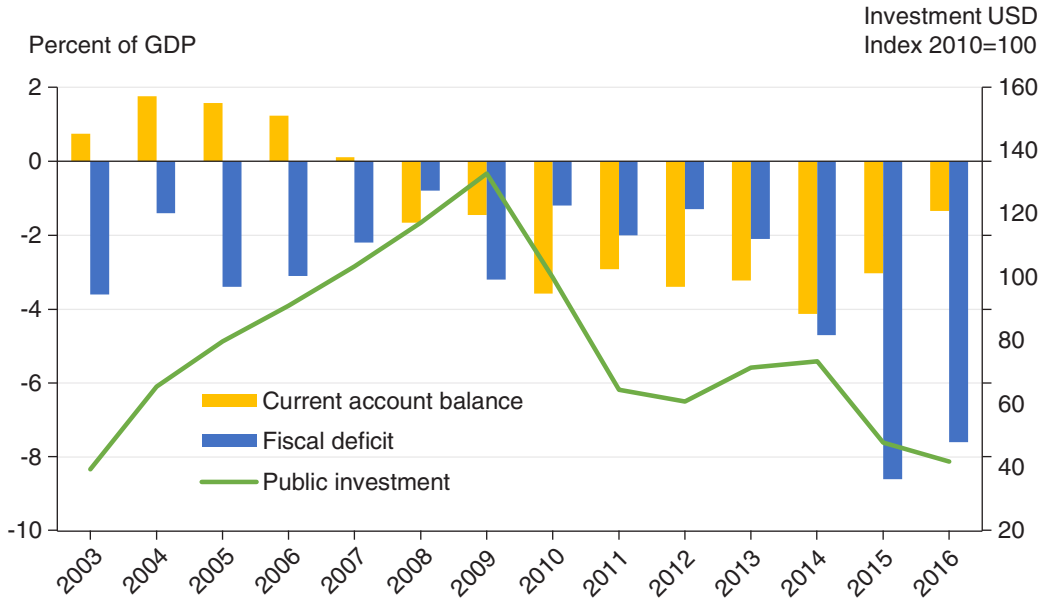
Note: GDP=Gross Domestic Product.

Source: USDA, Economic Research Service using data from the World Bank, Commodity Markets Outlook, 2019 and Instituto Brasileiro de Geografia e Estatística, 2019.

[1]A fiscal deficit is a shortfall in a government's income compared with its spending while a current account deficit indicates that the value of a country's net foreign assets (i.e., assets less liabilities) shrank.

Figure 3

Brazil's fiscal deficit, current account balance, and public investment, 2003-16



Note: GDP=Gross Domestic Product, USD=U.S. Dollar.

Source: USDA, Economic Research Service using data from World Bank, Banco Central do Brasil, 2019 and Instituto Brasileiro de Geografia e Estatística, 2019.

During the 2014-16 recession, the BRL saw one of its sharpest depreciations against the U.S. dollar, with the exchange rate rising by 44 percent between 2014 and 2015, while the devaluation led to faster inflation and higher interest rates (table 1). Inflation exceeded 10.4 percent in 2015, as energy and fuel prices were raised to boost the earnings of Brazil's public oil agency, Petrobras (ANP, 2018). These economic factors and increased fuel prices are incorporated in the reference (recession) scenario (analyzed in the next section).

Brazil's Central Bank raised the benchmark interest rate from 10.9 percent to 13.4 percent in 2015, which peaked at 14.1 percent in 2016 (table 1). The increase in the benchmark rate pushed market interest rates higher, from 24.2 percent in 2014 to 29.8 percent in 2015 and 31 percent in 2016. With the cost of credit increasing, private credit offered to farmers contracted 3.1 percent in 2015 and 6.7 percent in 2016 (Banco Central do Brasil, 2019).

Table 1

Brazil: selected economic indicators, 2014–18

	2014	2015	2016	2017	2018
Per capita GDP, change (percent)	-0.3	-4.5	-4.3	-0.6	0.9
Consumption, change (percent)	2.3	-3.2	-4.4	0.9	1.9
Investment, change (percent)	-4.2	-13.9	-10.4	-1.9	4.1
Total exports, change (percent)	-1.0	6.7	1.6	5.7	3.4
Total imports, change (percent)	-1.9	-14.0	-10.2	5.5	7.8
Exchange rate, (BRL/USD)	2.7	3.9	3.3	3.3	3.7
CPI, change (percent)	6.5	10.4	7.0	2.8	4.1
Interest rate (percent)	10.9	13.4	14.1	10.1	8.5

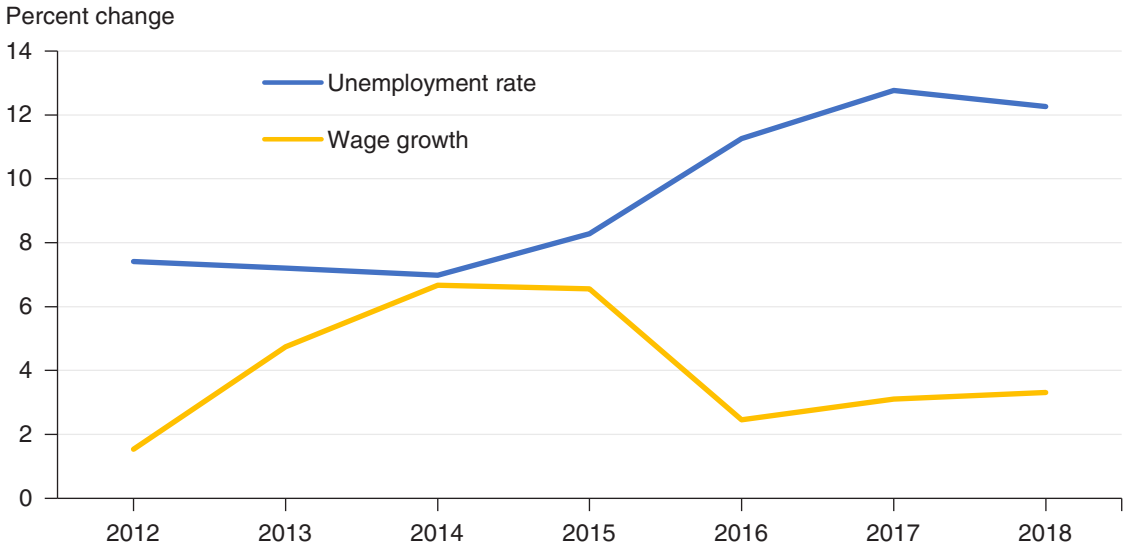
Notes: BRL=Brazilian real, USD=U.S. dollar, CPI=Consumer Price Index, GDP=Gross Domestic Product.

Sources: Banco Central do Brasil, *Indicadores Conjuntura*, 2018; Trade Data Monitor, 2020; Oxford Economics, 2018.

Beginning in 2014, unemployment surged, peaking at nearly 13 percent in 2017 while wages (market wages plus minimum wages) sustained their level in 2014-15 but later declined as unemployment and under-employment increased (fig. 4). As a result, per capita GDP and consumption declined in 2015 and 2016.

Figure 4

Brazil's unemployment and wages, 2012-18

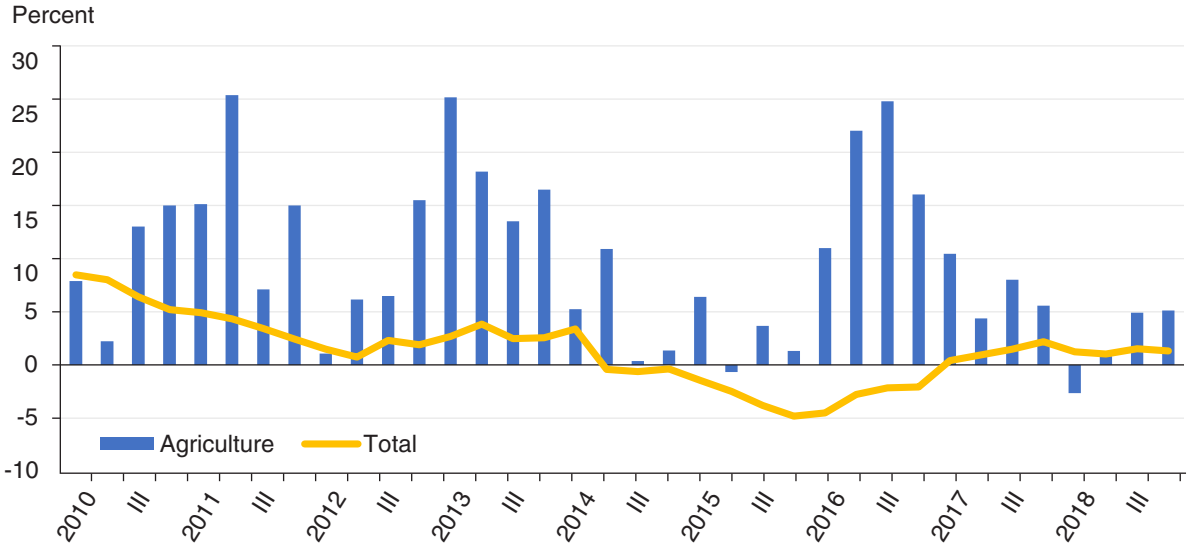


Source: USDA, Economic Research Service using data from Instituto Brasileiro de Geografia e Estatística.

Because of these changing macroeconomic conditions, GDP had declined 0.4 percent by the end of the second quarter of 2014. A severe contraction in Brazil's economy during 2015 and 2016 bottomed out with 4.8-percent contraction in the fourth quarter of 2015 and wiped out 5 consecutive years of economic growth (fig. 5). The industrial sector was adversely affected by the stagna-tion of domestic and foreign demand, but agricultural output growth was more resilient, posting 8.5 percent growth in 2014-16, primarily from gains in productivity. In 2015-18, agriculture's value added as percent of GDP was 8 percent, compared to 29 percent for the industrial sector and 63 percent for the services sector (World Bank, 2019).

Figure 5

Brazil's agricultural and total GDP growth, 2010-18



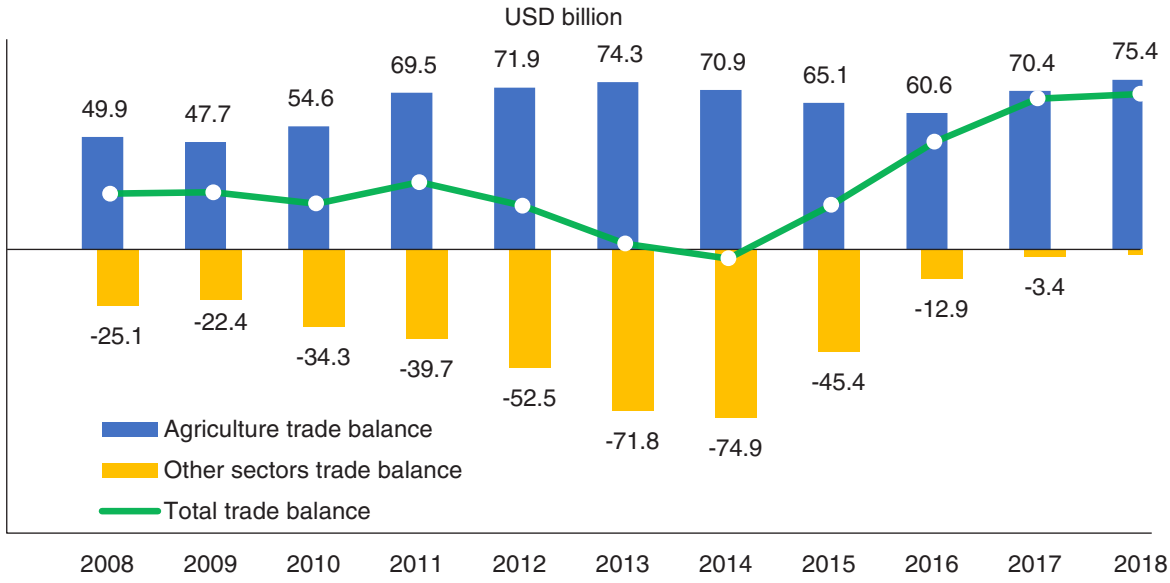
Note: GDP=Gross Domestic Product

Source: USDA, Economic Research Service using data from Banco Central do Brasil, 2019.

Brazil's total merchandise exports responded favorably to the devaluation and grew 6.7 percent in 2015, while total imports declined, reflecting the overall slowdown of the economy (table 1). Brazilian exports of manufactured goods did not respond to the depreciation during 2011-14 because of slowdowns in the growth of demand. However, Brazil's agricultural trade surplus was robust, even as the non-agricultural trade balance deteriorated (fig. 6).

Figure 6

Brazil's agricultural trade balance and total trade balance, 2008-18

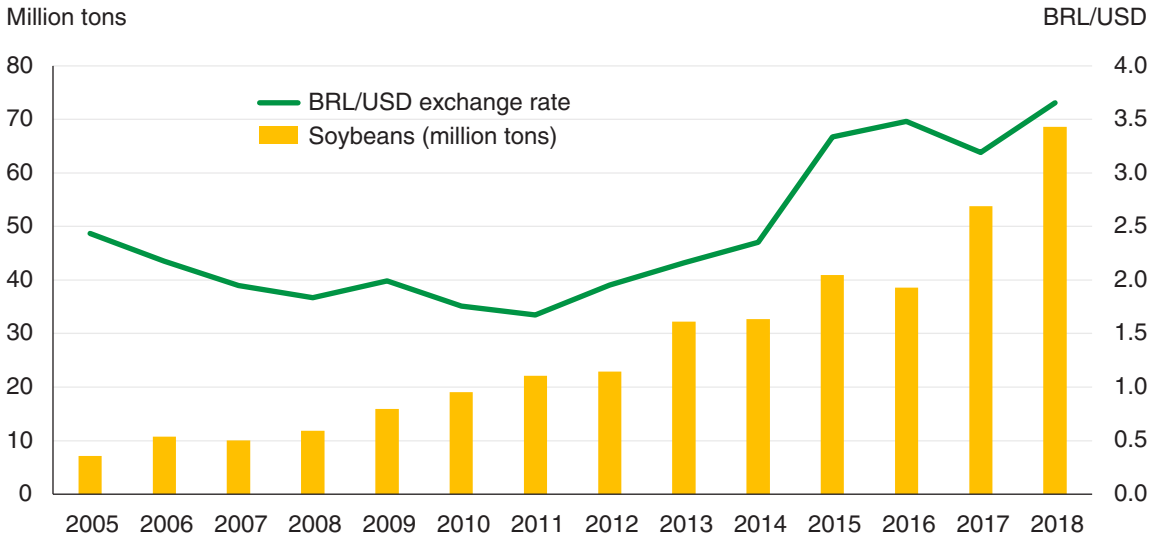


Note: USD=U.S. dollar.

Source: USDA, Economic Research Service using data from Trade Data Monitor, 2020.

Because of gains in yields and area, Brazil's oilseed and grain production grew 12 percent annually between 2000 and 2018 (FAS, 2019c). Brazil's soybean production closely rivals that of the United States with each accounting for 33-36 percent of world production (USDA/OCE, 2019). Brazil is also the world's third largest corn producer with about 8 percent of global production (USDA/OCE, 2019). With the growth in production creating surpluses for export, Brazil has emerged as a major oilseed and grain exporter. During 2000-16, Brazil exported an average 37 million metric tons of soybeans a year and 13 million metric tons of corn (Trade Data Monitor, 2020). China's increasing demand for soybeans played a key role in stimulating growth in Brazil's agricultural exports (Gale, Valdes, and Ash, 2019). Soybean exports increased from 7.2 million metric tons in 2005 to 68.6 million metric tons in 2018, aided by the substantial depreciation of the Brazilian BRL (fig. 7).

Figure 7
Brazil's soybean exports to China, 2005-18



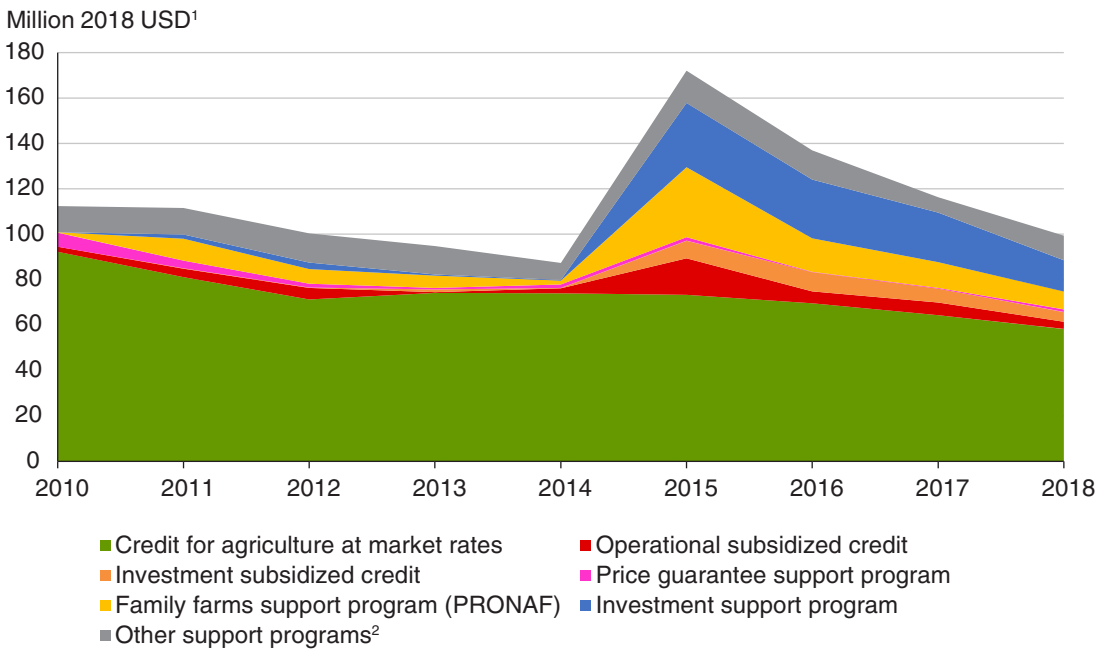
Notes: BRL=Brazilian real, USD=U.S. dollar.

Source: USDA, Economic Research Service using data from Trade Data Monitor, 2020 and Banco Central do Brasil, 2019.

Although agricultural credit—particularly short-term production credit—continued to receive preferential treatment, an overall tightening of credit policies to control inflation since 2011 also constrained agricultural lending (Banco Central do Brasil, 2019). During the recession, the availability of banking credit for agriculture dropped by 23 percent in real terms between 2014 and 2015 and has been declining slowly since then (fig. 8). Government-subsidized credit in Brazil declined from 2011 to 2014, but it surged during the peak of the recession in 2015 (fig. 8). Other types of government transfers to producers of certain agricultural products, including soybeans and corn, increased in real terms during the 2014-16 recession to maintain production incentives. These programs, through direct financial assistance to farmers in commodity programs and through subsidies, paid for crop marketing and crop insurance, and provided a total of US$25.9 billion in assistance to Brazilian producers during 2015-18 (Banco Central do Brasil, 2019). While administered interest rates for subsidized credit available to agriculture were stable during the recession, the lack of other forms of credit was reflected in high interest rates that undermine economic performance. The government working capital credit for producers of certain agricultural products, including soybeans, was increased during the 2014-16 recession to maintain production incentives.

Figure 8

Brazil's bank credit for agriculture and Government transfers to farmers, 2010-18



Note: USD=U.S. Dollar.

[1]Deflated with the gross domestic product (GDP) chained price index.

[2]Other support programs include insurance subsidies, marketing loan benefits, agricultural debt refinancing, and commodity direct payments (coffee, cocoa, and ethanol).

Source: Brazil Ministry of Finance, National Treasury budget expenditures 2010-2018.

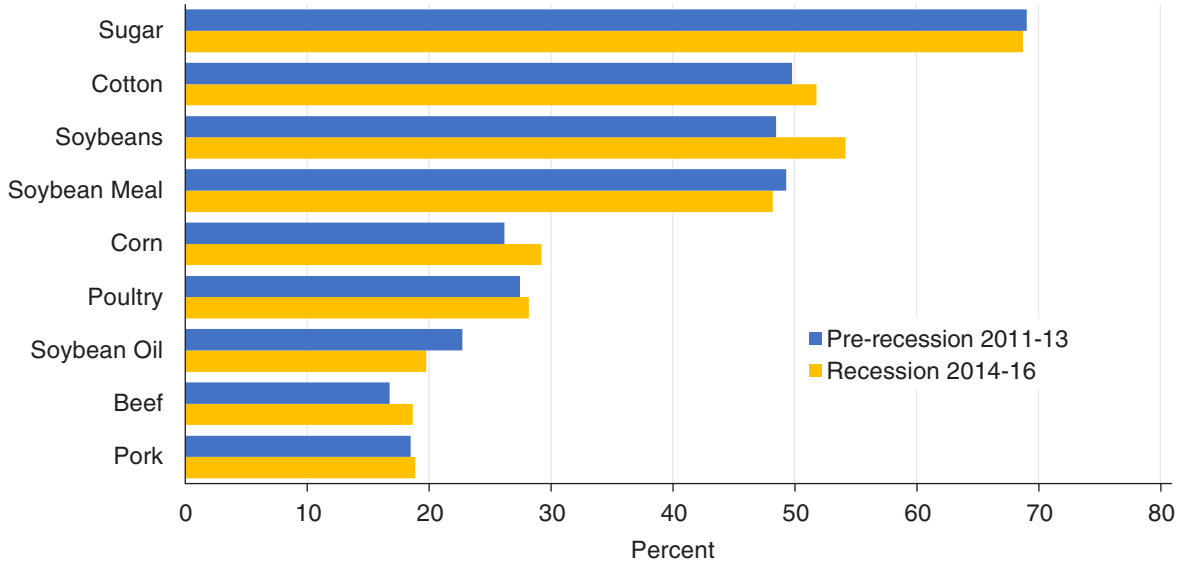
During the 2014-16 recession, Brazil's output of major agricultural commodities—including grains, oilseeds, sugarcane, and meats—continued to grow despite weak domestic demand and low prices in international markets. Brazilian farmers became more reliant on export sales as the depreciating BRL kept exports profitable. Export revenues received by Brazilian farmers in local currency increased as farmers received more BRL for each dollar of export revenues. Higher BRL-denominated output prices outweighed higher production expenses for imported fuels, fertilizer, and farm chemicals priced in U.S. dollars.[2] Consequently, the share of Brazil's cotton, soybeans, corn, and livestock products sold to export markets rose during the recession, countering the slowdown in domestic demand (fig. 9).

In 2014-16, Brazil exported 54 percent of the soybeans, 48 percent of soymeal, and 19 percent of soy oil it produced (USDA/FAS, 2019a). During the recession, soybean meal and soybean oil shares were down as fewer soybeans for crushing were available in 2015-16. This was caused by a reduction in soybean-planted area in response to low global soybean prices and higher interest rates, combined with the preferential tax rate favoring exports of beans instead of products (USDA/FAS, 2019b). Sugar remained highly export-oriented with 69 percent exported before and during the recession. The growth of the livestock and poultry sectors as a result of higher export demand resulted in a larger share of the soymeal produced during the 2014-16 recession period being used for domestic

[2]Devaluation of the BRL tended to raise the costs of production for crops and cultivated pasture because most fertilizers and agrochemicals used in Brazil are imported. Field costs also increased as a result of higher fuel prices during 2014-16 (Valdes et al., 2016).

animal feeding. The 2014 increase in the biodiesel mandate to blend up to 7 percent of biodiesel to the country's diesel supply (B7) led to higher domestic soybean crushing demand and consumption and lower soybean oil exports.

Figure 9
Export share of Brazil's farm production

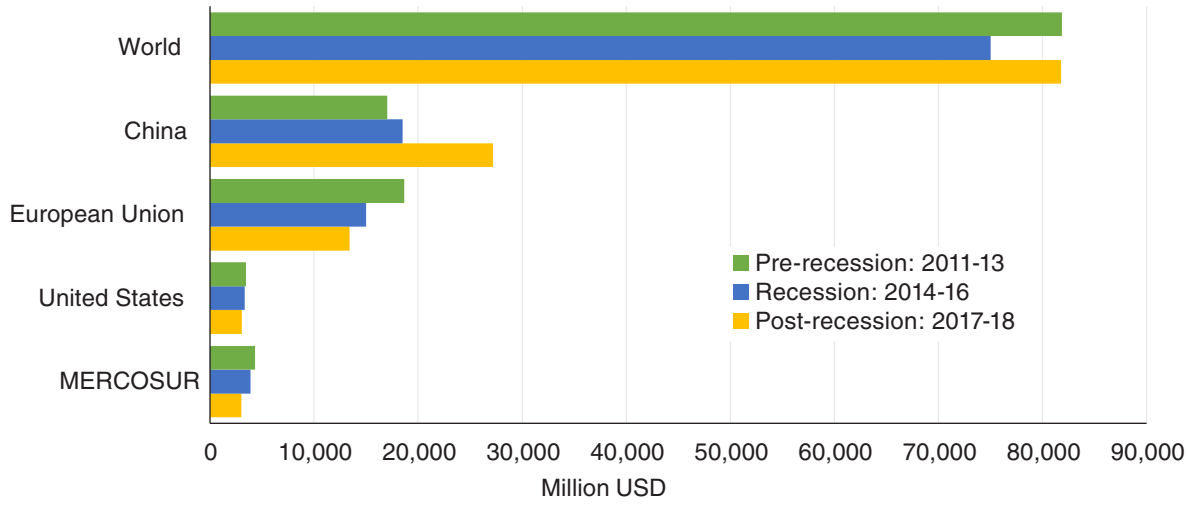


Source: USDA, Economic Research Service using data from USDA, Foreign Agricultural Service, *Production, Supply, and Distribution* database, 2019c.

As exchange rates kept Brazil's commodities competitively priced, China's growing demand for Brazil's soybeans and other commodities spurred growth in agricultural exports after the recession (fig. 10). China was the destination for 77 percent of Brazil's soybean exports in 2016/17, and sales to China accounted for 43 percent of Brazil's soybean crop that year (Gale, Valdes, and Ash, 2019). China is also a top market for Brazil's sugar, cotton, coffee, and meat exports. Brazil's exports sales to China increased further after the recession when China imposed higher tariffs on U.S. agricultural products in 2018. By contrast, Brazil's exports to other important markets (e.g., the European Union, the South American trading bloc composed of Brazil, Argentina, Paraguay and Uruguay known as the MERCOSUR) decreased. Manufactured exports grew much slower, reflecting sluggish international demand and the difficulty of rapidly restructuring manufacturing production.

Figure 10

Brazil's agricultural exports by destination before and during the recession



Notes: MERCOSUR=Southern Common Market, USD=U.S. Dollar.

Source: USDA, Economic Research Service using data from Trade Data Monitor, 2020.

Analyzing Future Scenarios for Brazilian Agriculture

USDA annually projects global supply and demand for major agricultural commodities for the next 10 years using the Country-Commodity Linked System (CCLS) of partial equilibrium models (see appendix, A Model of Brazilian Agriculture and the Country-Commodity Linked System (CCLS)). USDA projections of production, use, and exports and imports of commodities by major countries and regions are based on an analysis that combines historical trends, assumptions about future global macroeconomic trends, agricultural policies and weather, CCLS results, and the judgment of USDA experts.

As one of the top producers and exporters, Brazil plays an important role in the projections. USDA's projections for 2019-28—released in March 2019—showed continued growth in Brazil's production and exports of soybeans, corn, cotton, beef, and poultry (USDA/OCE, 2019). The projections for 2019-28 showed an even stronger outlook for Brazil's agricultural production and exports compared to a year earlier, as Brazilian exports to China accelerated after that country imposed tariffs on U.S. commodities in 2018 (USDA/OCE, 2019). This study uses the 2019-28 projections as a reference scenario for comparison with outcomes of alternate scenarios (See box, "Scenario timing").

The 2019-28 projections factored in a relatively weak macroeconomic outlook for Brazil. The projections were based on historical data that included its 2014-16 recession and recovery: Real GDP growth was 1 percent in 2017 and was expected to accelerate to 3 percent by 2024. That growth outlook was slow in comparison with that of other developing countries and slower than had been anticipated before the 2014-16 recession. For example, USDA's projections to 2024—released in February 2015—included slower GDP growth for 2014 but did not anticipate Brazil's recession extending into 2015-16 and expected GDP growth of 4 percent in 2014-24.

Scenario timing

The 2019-28 projections were the most recent available when this analysis was conducted. These projections were based on data and policies through 2018. Since then, data for 2019 have become available; under these new base projections, average exports for individual commodities are about 1.3-1.4 percent higher compared to 2018-base projections. The simulations of different scenarios compared with the 2019-28 reference projections still have value in evaluating the sensitivity of supply, demand, and trade to changing assumptions regarding exchange rates and GDP growth.

In 2019, Brazil's agricultural exports increased 4 percent. Its GDP growth slowed to 1.1 percent. The U.S. dollar also strengthened against Brazil's BRL in 2019, reaching BRL$4.1 by December. These continued macroeconomic fluctuations during 2019 reinforce the importance of this type of analysis.

The 2014-24 projections also underestimated the depreciation of Brazil's currency, slowing the depreciation rate to just 3 percent annually in 2014-24, as Brazil's strengthening economy was expected to regain part of the nearly 30-percent loss in value it experienced during 2015. The review of historical data above highlighted the impact of Brazil's currency depreciation and the countercyclical growth of its agricultural sector during the 2014-16 recession. This research assessed the impact of Brazil's macroeconomic performance on its agricultural production and exports by simulating two counterfactual scenarios using the USDA model:

1. An accelerated devaluation scenario in which Brazil's BRL depreciates against the U.S. dollar at a faster pace than assumed in the 2019-28 projections. It assumes an abrupt 31 percent devaluation in 2019—the first year of the projection period—and a cumulative devaluation of 24 percent thereafter through 2028; and

2. A sustained-GDP-growth scenario in which Brazil's GDP growth remained robust after 2014, never went into recession, and continued to grow an average of 3.2 percent annually until 2028.

These two scenarios are compared for the set of macroeconomic variables, petroleum, and domestic fertilizer nutrient prices.

Shifts in the value of the dollar, global income growth, petroleum prices, and changes in the macroeconomic outlook for major Brazilian markets and competitors also affect Brazil's macroeconomic performance. These effects arise through changes in global trade and ensuing world commodity prices projected under the higher economic growth and devaluation scenarios. We incorporated each of these two macroeconomic scenarios in the Country-Commodity Linked System model to generate alternative projections of Brazil's agricultural output, exports, domestic consumption, and other variables for 2019-28. New values for the projection period from 2019 to 2028 were projected and compared with the values reported in *USDA Agricultural Projections to 2028* published by USDA, Office of the Chief Economist in 2019. Differences between values generated in the alternative scenarios and the reference values in the 2019-28 projections show the sensitivity of projections to macroeconomic assumptions.

The sustained-GDP-growth analysis is conducted in two parts since this scenario begins before the 2018 base year. First, we generated new values for the recession-recovery period 2014-18 by assuming GDP growth, interest rates, inflation, and the exchange rate continuing historical trends before 2014 reported in the 2015 ERS baseline macroeconomic projections over the 10-year projection period (USDA/OCE, 2015). This initial analysis generated new starting values for 2018 that are used to generate new values for 2019-28 for the sustained-GDP-growth analysis.

Petroleum prices are important to Brazil's agricultural sector through their influence on farm inputs, such as fertilizer and agrochemicals, and impacts on demand for fuel ethanol, one of the chief products made from Brazil's sugarcane. Additionally, all gasoline sold in Brazil is a blend of crude oil-derived gasoline and ethanol. Inflation-adjusted oil prices were projected to remain below US$50 per barrel during 2019 and 2020, before rising 15 percent to about US$57 per barrel by 2028 (table 2). Maintenance of policy incentives such as the historical mandate for the use of renewable fuels in gasoline (27-percent blend rate) and the continuation of current producer policies are also assumed. These factors influence projected commodity prices and domestic production, consumption, and trade.

Table 2
Brazil's reference (recession) scenario macroeconomic and domestic fertilizer price assumptions, 2019-28 average

	Reference (recession) scenario	Average annual growth (percent)
Real GDP (2010 billion USD)	2,737	3.2
Per capita GDP (2010 USD/person)	12,641	2.6
Real exchange rate (2010 BRL/2010 US$)	2.67	0.2
Real average wages (2010 BRL/2010 US$)	2,894	3.0
Consumer price index (2010=100)	203.14	4.0
Real interest rate (percent)	8.11	-1.6
Real petroleum price (2010 US$/barrel)	54.47	2.1
Average urea price (2010 BRL/ton)	1,068	-0.5
Average phosphate price (2010 BRL/ton)	773	-0.1
Average potassium chloride price (2010 BRL/ton)	1,079	-0.2

Note: USD=U.S. dollar, BRL = Brazilian real.

Sources: USDA, Economic Research Service authors assumptions; USDA, Office of the Chief Economist, 2019.

The reference (recession) scenario projected expansion of soybean, corn, cotton, and sugar production, as net returns to these crops encourage new land to be brought into production and spur an increase in double-cropping during 2019-28. Rice and wheat production may be discouraged by expected costs that exceed revenues, principally because of higher costs for fertilizer, agrochemicals, and irrigation (table 3). Soybeans and sugar production were projected to expand as strong net returns encourage 5 million hectares of new land to be brought into production, mostly for these crops. In addition, double-cropping increases total harvested area by 19 million hectares during the projection period, a 25-percent increase over current cropland area.

Table 3
Expected returns to crop production in the reference (recession) scenario, 2019-28 annual averages

	Expected revenue, cost, and returns (2010 BRL/ha)[1]			Average annual growth rate (%)		
Commodity	Expected revenue	Expected cost	Expected returns ratio[2]	Expected revenue	Expected cost	Expected returns ratio
Corn	1,490	1,461	1.02	1.2	0.3	0.9
Cotton	5,936	4,302	1.38	1.7	1.7	0.0
Rice	2,946	3,069	0.96	0.1	1.9	-1.8
Soybeans	2,174	1,235	1.76	0.4	-0.7	1.1
Sugarcane	6,359	3,613	1.76	1.3	0.5	0.8
Wheat	1,060	1,082	0.98	1.1	0.5	0.6

Note: BRL=Brazilian real.

[1]Expected revenue and cost are denominated in 2010 BRL per hectare (2010 BRL/ha).
[2]The expected returns ratio is expected revenue divided by expected cost.

Source: USDA, Economic Research Service research results.

Falling domestic fertilizer prices in the reference scenario contribute to the increase in net returns for farmers. Prices for urea and phosphate were projected to decline 0.5 and 0.1 percent annually, respectively, over the 2019-28 period. Corn, rice, and cotton benefit the most from lower urea prices as these crops are large consumers of nitrogen, while soybeans and wheat are the largest consumers of phosphates (CONAB, 2018). Sugarcane and soybeans benefit from a 0.2 percent annual average reduction in the price of potash over the projection period. These lower costs contribute to higher annual returns to soybeans (1.1 percent), corn (0.9 percent), and sugarcane (0.8 percent) through 2028 (table 3). With these higher returns, the reference scenario projected an additional 1.24 million hectares of soybeans would be harvested between 2019 and 2028, reaching over 41 million hectares by 2028 (table 4). During the same period, corn area rises by 1.54 million hectares. Returns to wheat producers rise 0.6 percent annually, with slightly higher returns to sugarcane production. Rice producers see declining returns of 1.8 percent per year, on average, mainly because of higher fertilizer and agrochemical costs.

Table 4
Reference (recession) scenario producer prices, area harvested, and production of major crops, average 2019-28

Commodity	Producer price	Area harvested	Production	Producer price	Area harvested	Production
	(2010 BRL/mt)	(Mil. ha)	(Mil. mt)	Annual average growth rate (percent)		
Beef	10,408.5	--	11.0	0.0	--	1.8
Corn	251.3	19.4	114.0	-0.3	1.8	3.1
Cotton	3,497.3	1.2	2.1	0.0	1.2	2.9
Ethanol[1]	96.0	--	35.6	0.1	--	3.8
Pork	2,608.1	--	4.1	-0.8	--	1.4
Poultry	1,793.6	--	16.7	-0.6	--	2.7
Rice	486.2	2.1	8.4	-0.7	0.3	0.9
Soybeans	621.4	41.0	138.7	-1.0	2.6	4.0
Sugar	535.5	--	43.5	0.9	2.5	3.1
Sugarcane	69.1	10.3	782.4	0.9	2.5	3.1
Wheat	390.3	2.2	6.0	-0.6	0.2	0.9

[1]Ethanol production is in billion liters.

Note: Prices are denominated in 2010 BRL per metric ton, except for ethanol which is 2010 BRL per 100 liters;

-- = not applicable, ha = hectares, mt = metric ton, mil=million, BRL = Brazilian real

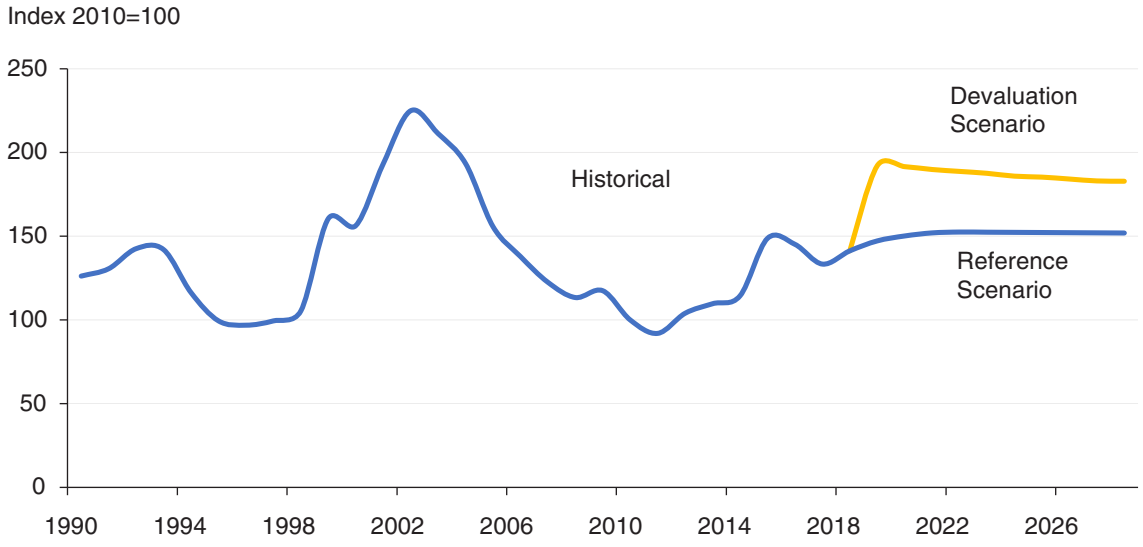
Source: USDA, Office of the Chief Economist (2019) and USDA, Economic Research Service research results.

Mills in Brazil have the flexibility to partially switch sugarcane toward sugar or ethanol production in response to market prices. During the recession, world sugar prices rose significantly (5 percent per year between 2014 and 2016) due primarily to lower global production, which generated a surge in the amount of sugarcane milled for sugar, rising by an annual average increase of 337 million metric tons over 2019-28, subsequently adding 43.5 million metric tons of sugar over the same period (table 4). Weaker income growth during the 2014-16 recession negatively affected gasoline consumption, which was compounded by a 25-percent reduction in the number of flex-fuel cars added to the national inventory (Anfavea, 2018). With economic recovery, demand for gasoline and fuel ethanol increases 2.7 percent and 4.5 percent per year, respectively, during 2019-28. In the reference (recession) scenario, higher wheat and rice production and a sell-off of stocks lead to lower consumer prices and higher consumption, despite slower per capita income growth.

Accelerated Devaluation Scenario

This section provides estimates of the effects of a more rapid devaluation of the BRL on the 2019 USDA projections for Brazilian agriculture and global commodity trade. In the reference scenario described in the previous section, the BRL was assumed to depreciate modestly during the projection period (fig. 11). In this scenario, the BRL depreciates 31 percent more than in the reference scenario in 2019, followed by a sustained average devaluation of 24 percent above the base or reference exchange rate through 2028 (fig. 11). Even though a maxi-devaluation of the Brazilian currency was not a likely event in the short term prior to the COVID-19 shock that led the BRL to a record low against the dollar in 2020, a devaluation may occur again in the future. For example, the BRL could fall because of a growing fiscal deficit and the lack of reform to reduce the fiscal burden of the pension system (Banco Central do Brasil, 2019).

Figure 11
Brazil's historical real exchange rate and alternative projections, 1990-2028



Note: The exchange rate is defined here as the amount of Brazilian currency BRL per unit of U.S. dollar. An increase in the exchange rate implies a depreciation of the BRL from the domestic consumer's perspective and a currency strengthening from the buyers' perspective. BRL=Brazilian real.

Source: USDA, Economic Research Service (ERS) using ERS International Macroeconomic Data Set (2019); and USDA Agricultural Projections to 2028.

A more rapid devaluation of the BRL results in higher net returns to Brazilian growers of all crops except sugarcane. With higher net returns, Brazil's area harvested and production increase for all the commodities modeled except sugarcane. Pork and poultry production in Brazil, however, is negatively affected by higher feed prices, and beef output is unchanged as the expansion of crop area diverts land from pasture uses. Brazil's exports of all commodities, except beef, increase in the rapid-devaluation scenario as the country gains a greater share of world markets. International (dollar-denominated) commodity prices decline relative to the reference scenario, but net returns to Brazilian farmers in local currency are sustained by the devalued BRL. The impacts of an accelerated devaluation relative to the current baseline assumptions are reflected in the change from the reference scenario in the following tables in this section.

With accelerated depreciation, higher net returns increase soybean area by 1.1 million hectares per year (average over 2019-28), and production rises 4.3 million metric tons per year (3.1 percent average over 2019-28) to 170 million metric tons in 2028 (tables 5 and 6). Revenue to corn producers rises by nearly 15 percent annually (table 5), despite a 6.3-percent increase in expected costs. As a result, nearly 800,000 additional hectares of corn per year (average over 2019-28) are harvested. Over the same period, corn production increases 5.7 million metric tons per year (5.0 percent, average over 2019-28) (table 6). Annual production of cotton, rice, and wheat increase in response to higher revenue and lower production costs: Cotton production is up 28,000 metric tons; rice, 34,000 metric tons; and wheat, 285,000 metric tons.

Sugarcane area declines 1.0 percent in the accelerated depreciation scenario as higher production costs resulting from more expensive imported fertilizers reduce the returns to sugarcane cultivation. Marginally lower producer returns for sugar resulting from higher cultivation costs and a lower ethanol price lead to a 1-percent decline in area harvested annually from 2019 to 2028 and lower production. Total sugarcane milled for ethanol declines, but sugarcane milled for sugar production rises to meet increasing demand (2.7 percent annually between 2019 and 2028). The net impact is a decrease in sugarcane production during 2019-28 of 8 million metric tons per year, on average. Ethanol production in Brazil declines 3.9 percent per year through 2028 (1.4 billion liters per year on average over the 10-year period). Given this decline, Brazil's sugar production and sugar exports are up by an annual average of 4.1 percent and 6.1 percent, respectively, over the period (tables 6 and 7). With higher prices for feed grains, domestic feed demand is lower, so poultry production falls by an average of 1.8 percent annually while pork output declines by an average of 1.4 percent per year (table 6).

Table 5

Expected returns to crop production with accelerated devaluation, 2019-28 annual averages

	Expected revenue, cost, and returns (2010 BRL/ha)[1]			Change from reference (recession) scenario (percent)		
Commodity	Expected revenue	Expected cost	Expected returns ratio[2]	Expected revenue	Expected cost	Expected returns ratio
Corn	1,778	1,553	1.15	14.9	6.3	7.6
Cotton	6,866	4,622	1.49	15.7	7.4	7.4
Rice	2,950	3,229	0.91	12.1	5.2	6.4
Soybeans	2,458	1,260	1.95	12.9	2.0	9.6
Sugarcane	6,582	3,706	1.78	2.3	2.6	-0.2
Wheat	1,234	1,100	1.12	16.5	1.7	14.4

Note: BRL=Brazilian real.

[1]Expected revenue and cost are denominated in 2010 BRL per hectare (2010 BRL$/ha).

[2]The expected returns ratio is expected revenue divided by expected cost.

Source: USDA, Economic Research Service research results.

Table 6

Devaluation scenario price, area, and production relative to the reference (recession) scenario, average 2019-28

	Producer price (2010 BRL/ton)		
Commodity	Reference (recession) scenario	Devaluation scenario	Change from reference (percent)
Beef	10,408.5	10,615.6	2.0
Corn	251.3	295.0	17.4
Cotton	3,497.3	4,163.7	19.1
Ethanol[1]	96.0	96.0	-0.1
Pork	2,608.1	2,964.2	13.7
Poultry	1,793.6	1,968.0	9.7
Rice	486.2	559.7	15.1
Soybeans	621.4	715.5	15.2
Sugar	535.5	583.5	9.0
Sugarcane	69.1	76.3	10.4
Wheat	390.3	461.3	18.2
	Area harvested (1,000 hectares)		
Commodity	Reference (recession) scenario	Devaluation scenario	Change from reference (percent)
Corn	19.4	20.2	3.8
Cotton	1.2	1.2	0.5
Rice	2.1	2.1	0.1
Soybeans	41.0	42.1	2.7
Sugarcane	10.3	10.2	-1.0
Wheat	2.2	2.3	3.3
	Production (million tons)		
Commodity	Reference (recession) scenario	Devaluation scenario	Change from reference (percent)
Beef	11.0	11.0	0.0
Corn	114.0	119.7	5.0
Cotton	2.1	2.1	1.3
Ethanol[2]	35.6	34.2	-3.9
Pork	4.1	4.0	-1.4
Poultry	16.7	16.4	-1.8
Rice	8.4	8.4	0.4
Soybeans	138.7	143.0	3.1
Sugar	43.5	45.3	4.1
Sugarcane	782.4	774.4	-1.0
Wheat	6.0	6.3	4.8

Note: BRL=Brazilian real.

[1]The ethanol price is per 100 liters. [2]Ethanol production is in billion liters.

Source: USDA, Economic Research Service research results.

Table 7
Devaluation scenario exports relative to the reference (recession) scenario, average 2019-28

	Exports (million tons)		
Commodity	Reference (recession)scenario	Devaluation scenario	Change from reference (percent)
Beef	2.5	2.4	-2.1
Corn	39.5	44.6	12.9
Cotton	1.5	1.5	3.2
Ethanol[1]	1.3	1.1	-13.7
Pork	1.0	1.0	2.4
Poultry	5.5	5.9	5.5
Rice	1.1	1.2	8.3
Soybeans	80.2	83.9	4.5
Soybean meal	17.5	17.5	0.1
Soybean oil	2.0	2.2	9.8
Sugar	32.2	34.2	6.1
Wheat	0.8	0.8	3.1

[1]Ethanol exports is in billion liters.

Source: USDA, Economic Research Service research results.

The projected strong growth in Brazil's soybean production and exports depresses international soybean prices, which decline relative to the reference (recession) scenario by an average of 4.9 percent per year through 2018 (table 8). Increased output of soybean oil from crushing more soybeans reduces world prices by 6.4 percent, while soybean meal prices fall 2.1 percent.

Table 8
Change in world reference prices under devaluation scenario, 2019-28 average

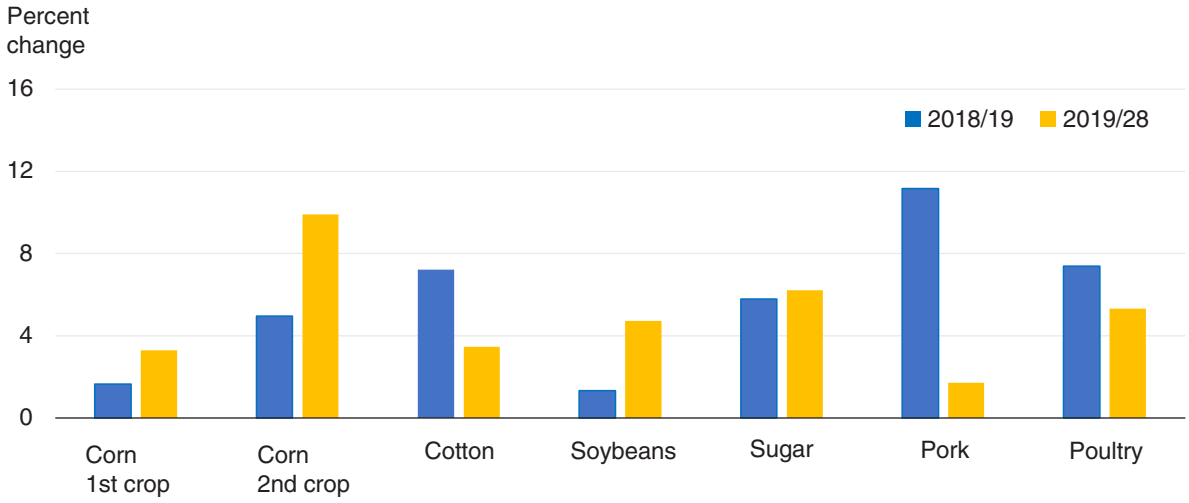
	Percent change from reference value	Change from reference value (2010 USD/ton)
Beef	-0.5	-4
Corn	-4.1	-5
Cotton	-1.2	-16
Pork	-1.2	-14
Poultry	-2.9	-43
Rice	-1.0	-3
Soybeans	-4.9	-15
Soybean meal	-2.1	-6
Soybean oil	-6.4	-49
Sugar	-6.2	-31
Wheat	-2.0	-4

Note: USD= U.S. dollar.

Source: USDA, Economic Research Service research results.

In the accelerated depreciation scenario, Brazil exports more of each major commodity except beef. Sugar exports from Brazil (up 6.1 percent per year, or nearly 2 million metric tons) increase more than sugar exports from other countries (fig. 12). Brazil's soybean exports increase by 4.5 percent (3.6 million metric tons annually) while exports from the United States and Argentina decline (table 9). Corn exports increase 12.9 percent or over 5.1 million metric tons in 2019-28.

Figure 12
Impact of rapid devaluation of Brazil's currency on commodity exports[1]
Percent differences from reference (recession) scenario



Note: BRL=Brazilian real.

[1]Change in Brazil's commodity exports in a scenario that assumes accelerated devaluation of the BRL above the exchange rate levels in the USDA 2019 reference baseline, applied to the 2019-2028 projection period.

Source: USDA, Economic Research Service research results.

Table 9
Change in exports under devaluation scenario, 2019-28 annual average

	Beef	Corn	Cotton	Pork	Poultry	Rice	Soybeans	Sugar	Wheat
					1,000 tons				
Argentina	13.1	-489.0	2.8	0.0	-3.7	5.6	-1,286.6	-0.2	-103.9
Australia	0.0	--	11.0	-0.9	-17.5	0.0	-0.8	-135.3	-64.5
Brazil	-51.8	5,097.4	46.8	22.6	302.4	89.5	3,631.4	1,969.2	24.9
Canada	0.2	0.0	--	-2.0	0.2	--	-27.5	0.0	-78.9
European Union	1.0	0.0	-0.1	-1.3	-6.0	0.0	0.0	--	-161.7
India	-4.8	--	-12.6	--	0.0	-18.0	0.2	-0.4	-1.0
Russia	0.0	-167.2	--	0.0	-0.2	0.0	0.0	0.0	-28.8
Thailand	0.0	-3.7	--	0.1	-13.1	-8.5	--	-99.3	-0.1
Ukraine	0.4	-653.4	--	0.0	-3.9	--	0.0	25.4	-26.1
United States	-0.8	-932.5	-25.1	7.9	-19.3	98.0	-1,453.6	--	994.6
					Percent				
Argentina	2.7	-1.6	3.1	0.0	-1.6	1.1	-11.1	-0.2	-0.7
Australia	0.0	--	0.9	-1.9	-35.8	0.0	-43.8	-3.5	-0.3
Brazil	-2.1	12.9	3.2	2.4	5.5	8.3	4.5	6.1	3.1
Canada	0.0	0.0	--	-0.1	0.1	--	-0.4	0.0	-0.4
European Union	0.2	0.0	0.0	0.0	-0.4	0.0	0.0	--	-0.4
India	-0.2	0.0	-0.7	--	0.8	-0.1	0.1	-0.1	-2.3
Russia	0.0	-2.5	--	0.0	-0.1	0.0	0.0	0.0	-0.1
Thailand	0.0	-1.6	--	0.2	-1.2	-0.1	0.0	-1.1	0.0
Ukraine	0.5	-2.3	--	0.0	-3.9	--	-1. 8	-2.3	-0.1
United States	-0.8	-1.8	-0.8	0.3	-0.5	2.7	-2.2	--	3.7

Note: -- = not applicable.

Source: USDA, Economic Research Service research results.

Sustained Economic Growth Scenario

A counterfactual scenario of sustained economic growth in the past (2014-18 period) and future (2019-28 period) was constructed by altering the domestic macroeconomics variables in the Brazil model—including domestic income growth, inflation rates, interest rates, and exchange rates. In the sustained growth scenario, new values were generated for GDP growth, interest rates, inflation, and the exchange rate during the recession-recovery period 2014-18 by assuming these values continued historical trends prior to 2014 that had been projected in the 2015 Economic Research Service baseline for those years (USDA/OCE, 2015).

In this scenario, per capita GDP grew faster than the reference scenario values in 2014-18 (years that include the 2014-16 recession), and real average wages (market wages plus minimum wages) rose 10 percent above baseline (recession scenario). Faster GDP growth implies faster wage growth in Brazil, where by law, the minimum wage must be increased by the rate of inflation during the previous year plus the real rate of GDP growth 2 years prior (Banco Central do Brasil, 2019). While there is a lag in the adjustment of the minimum wage to GDP growth, under the high growth scenario, both market wages and minimum wages rise, compared to the base (recession) scenario,

resulting in higher real average wages. The net effect of these and other factors—including increased employment—is a boost in demand in the sustained economic growth scenario. The average real exchange rate depreciates a bit relative to the reference rate, averaging a 2.5-percent depreciation in 2014-18.

During the recession, the Central Bank of Brazil raised its official interest rate in order to limit capital outflows and support the exchange rate (Banco Central do Brasil, 2019). In the sustained growth scenario, the interest rate and consumer price index are lower than the values in the reference (recession) scenario by 4.4 and 2.1 percentage points, respectively. The exchange rate depreciation increases fertilizer prices with urea up 1.5 percent relative to the reference (recession) scenario. Phosphate prices are 1.1 percent higher, while farmers spend 1.4 percent more for potassium chloride in 2014-18.

In the first part of the sustained growth scenario (2014-18), there is little difference in Brazilian crop production or exports and little impact on world market prices compared with the reference scenario. Expected revenue for all major crops would have been only marginally higher (0.1 to 1.6 percent) than in the reference (recession) scenario. In the sustained growth scenario, Brazil would have exported less beef, pork, and corn. Additional quantities of corn would have been diverted to feed domestic pigs and poultry. Cotton and rice exports also would have been lower because of higher domestic demand. Soybean exports would have been only marginally higher in the sustained growth scenario as more soybeans are crushed for the Brazilian market, but sugar exports would have expanded by an average of 1.3 percent per year.

Under the sustained economic growth scenario, Brazil's annual corn exports during 2014-18 would have been 622,100 metric tons lower, but U.S. exports would have been 450,900 metric tons higher each year (table 10). Argentina, India, Russia, and Ukraine would have exported an additional 91,500 metric tons combined annually. The largest impact on Brazil's exports would have been a reduction of its beef exports by nearly 7 percent, mainly because of higher domestic consumption. Increases by other exporters—chiefly Argentina and India—would have replaced only 25 percent of Brazil's decline. Brazil's pork exports would have declined by 5 percent as consumer demand rises and production is unchanged, while its poultry exports would have risen 1.4 percent (table 10).

Table 10
Change in exports under sustained growth scenario versus reference (recession) scenario, 2014-18 average

	Beef	Corn	Cotton	Pork	Poultry	Rice	Soybeans	Sugar	Wheat
	1,000 metric tons								
Argentina	16.2	40.7	-0.2	--	-0.3	0.5	6.5	-0.1	-14.6
Australia	1.6	--	0.2	0.4	-1.4	0.1	-0.0	-16.8	-0.5
Brazil	-123.2	-622.1	-13.6	-38.6	59.1	-2.6	68.3	226.4	5.6
Canada	3.9	0.0	--	2.5	0.0	--	-0.3	0.0	-3.1
European Union	-0.1	0.0	0.0	6.8	-2.4	0.0	0.0	--	16.8
India	8.5	0.6	2.0	--	0.0	0.3	-0.1	-0.3	0.3
Russia	0.0	13.5	--	--	0.0	0.0	0.0	0.0	-0.4
Ukraine	0.2	35.3	--	--	-0.3	0.0	0.3	0.0	7.6
United States	3.8	450.9	3.3	2.9	-2.7	0.9	-80.0	--	38.3
	Percent								
Argentina	6.6	0.2	0.3	-0.0	-0.1	0.1	0.1	-0.0	-0.2
Australia	0.1	--	0.0	1.0	-3.5	0.1	--	-0.5	0.0
Brazil	-6.9	-2.2	-1.8	-5.3	1.4	-0.4	0.1	0.9	0.6
Canada	0.9	0.0	--	0.2	0.0	--	0.0	0.0	0.0
European Union	0.0	0.0	0.0	0.3	-0.2	0.0	0.0	--	0.1
India	0.5	0.0	0.2	--	0.0	0.0	0.0	0.0	0.0
Russia	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ukraine	0.2	0.2	--	-0.5	-0.1	0.0	0.0	0.0	0.1
United States	0.3	0.9	0.1	0.1	-0.1	0.0	-0.1	--	0.1

Note: -- = not applicable.

Source: USDA, Economic Research Service research results.

There would have been little difference in world prices under the 2014-18 sustained growth scenario compared to the reference scenario. Beef was the only commodity with a price change exceeding 1-percent: the net decline in beef exports would have led to a 1.3-percent increase in the world beef price from 2014 to 2018 (table 11). Reduced pork exports would have led to a 0.6-percent annual increase in the average world pork price, and Brazil's increase in poultry meat exports would have lowered the world price by 0.3-percent (table 11).

An additional 226,400 metric tons of sugar exported annually between 2014 and 2018 translate into an annual 0.7-percent decline in world sugar prices. Both Brazil and the United States reduce soybean exports in favor of domestic crushing in the sustained growth scenario. Consequently, an excess supply of soybean oil reduces world prices by an average of 5.2-percent, while soybean prices fall 0.1-percent and soybean meal prices are 0.1 percent higher on average between 2014 and 2018.

These results for the high growth scenario suggest that, relative to the reference (recession) scenario, world market prices of most meats, grains, and cotton would have been only slightly higher during 2014-18 had the Brazilian economy not entered a recession. These results suggest that Brazil's 2014-16 recession had minimal impacts on agricultural production and exports, leaving the surge of agricultural output that occurred during the 2014-16 recession unexplained.

Table 11
Annual change in world prices under the sustained growth scenario, 2014-18 average

	Percent	2010 USD/ton
Beef	1.3	22
Corn	0.2	*
Cotton	0.2	3
Pork	0.6	10
Poultry	-0.3	-5
Rice	0.0	*
Soybeans	-0.1	*
Sugar	-0.7	-3
Wheat	0.1	*

Note: USD=U.S. dollar, * = changes of less than 0.1 percent.

Source: USDA, Economic Research Service research results.

Model Projections Under the Sustained Growth Scenario versus the Reference (Recession) Scenario: Results for 2019-28

In the sustained growth scenario, the assumed values for 2014-18 generate new values for GDP growth, interest rates, inflation, and the exchange rate during the 2019-28 projection period, which in turn influence the agricultural projections. In this scenario, per capita GDP grew 14.4 percent faster than the reference scenario values in 2019-28, and real average wages (market wages plus minimum wages) rose 12 percent above baseline (recession scenario). The average real exchange rate depreciates 3.5 percent faster relative to the reference rate in 2019-28. The exchange rate depreciation increases fertilizer prices with urea up 2.6 percent relative to the reference (recession) scenario. Phosphate prices are 1.9 percent higher, while farmers spend 2.4 percent more for potassium chloride in 2019-28 (table 12).

The sustained growth scenario's stronger GDP growth for 2019-28 leads to long-term growth in Brazil's domestic demand for agricultural products. In combination with higher domestic biofuel demand (ethanol from sugarcane, ethanol from corn, and biodiesel from soybean oil), this long-term growth in demand leads to higher Brazilian producer prices. The stronger income growth prompts greater food consumption and feed use of commodities. Higher income stimulates faster growth in Brazil's demand for meat than for staple foods, leading to higher prices for livestock products and the feedstuffs used to produce them.

Table 12
Brazil's reference (recession) scenario and sustained growth macroeconomic and domestic fertilizer price assumptions, 2019-28 average

	Reference (recession) scenario	Average annual growth (%)	Sustained growth scenario	Average annual growth (%)
Real GDP (2010 USD billion)	2,737	3.2	3,132	3.2
Per capita GDP (2010 USD/person)	12,641	2.6	14,465	2.6
Real exchange rate (2010 BRL/2010 USD)	2.67	0.2	2.76	0.3
Real average wages (2010 BRL/2010 USD)	2,894	3.0	3,241	3.2
Consumer price index (2010=100)	203.1	4.0	196.3	3.9
Real interest rate (%)	8.11	-1.6	8.25	-1.6
Real petroleum price (2010 USD/barrel)	54.47	2.1	54.47	2.1
Urea price (2010 BRL/ton)	1,068	-0.5	1,096	-0.4
Phosphate price (2010 BRL/ton)	773	-0.1	788	-0.1
Potassium chloride price (2010 BRL/ton)	1,079	-0.2	1,105	-0.1

Note: USD=U.S. dollar, BRL=Brazilian real, GDP=Gross Domestic Product.

Source: USDA, Office of the Chief Economist (2019).

Under this scenario, expected producer revenue is higher than in the reference scenario for all major commodities. The increase in revenue ranges from 0.6 percent for sugarcane to 3.1 percent for corn (table 13). The increase in revenue offsets cost increases, resulting in 1.8 to 4.0 percent higher returns than in the reference scenario.

Table 13
Expected returns to crop production with sustained growth scenario, 2019-28 annual averages

	Expected revenue, cost, and returns (2010 BRL/ha)[1]			Change from reference (recession) scenario (percent)		
Commodity	Expected revenue	Expected cost	Expected returns ratio[2]	Expected revenue	Expected cost	Expected returns ratio
Corn	1,597	1,468	1.09	3.1	0.5	2.6
Cotton	6,088	4,281	1.42	2.5	-0.5	3.0
Rice	2,698	3,044	0.89	2.8	-0.8	3.6
Soybeans	2,237	1,243	1.80	2.5	0.7	1.8
Sugarcane	6,469	3,562	1.82	0.6	-1.4	2.0
Wheat	1,091	1,070	1.02	2.9	-1.1	4.0

Note: BRL=Brazilian real.

[1]Expected revenue and cost are denominated in 2010 BRL per hectare (2010 BRL/ha).

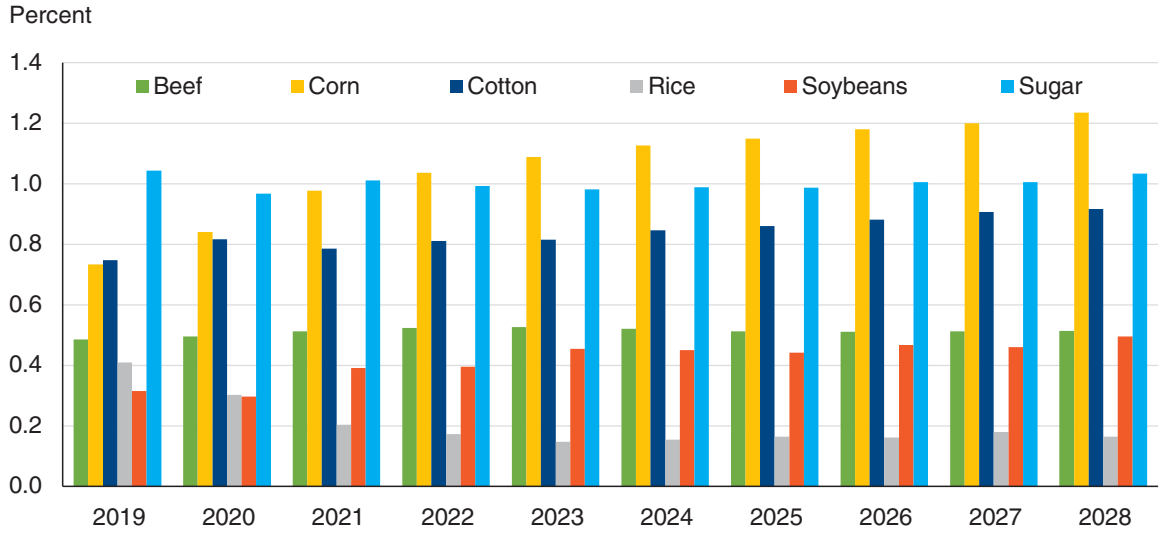
[2]The expected returns ratio is expected revenue divided by expected cost.

Source: USDA, Economic Research Service research results.

With higher net returns, area harvested and production of all crops is higher than in the reference scenario (fig. 13). Corn area expands by an additional 1.5 million hectares over the period 2019-28, while soybean area increases 1.2 million hectares (table 14). These increases add 12 million metric tons to corn production and 5.6 million metric tons to soybean production. Higher output of corn and soybeans supports higher long-term feed use by pork and poultry producers.

Rice and wheat production increase 0.2 and 1.5 percent per year, respectively, to meet domestic demand under the sustained growth scenario (table 14). Returns to cattle production increase with higher producer prices and lower fuel and pasture-related expenses, which results in higher beef production (up an annual average of 0.5 percent) during 2019-28. Higher producer prices for poultry meat offset higher prices for feed grains, and poultry production increases 909,000 metric tons per year, or 5.4 percent (average over 2019-28). In contrast, pork production is negatively affected by the higher feed costs, declining 0.2 percent or 8,000 metric tons per year (average over 2019-28) (table 14).

Figure 13
Change in production for selected Brazilian commodities from base values under sustained growth scenario, 2019-28



Note: These commodities account for 95 percent of the value of agricultural production in 2019-28.

Source: USDA, Economic Research Service research results.

Table 14

Sustained growth scenario price, area, and production in Brazil relative to the reference (recession) scenario, annual average 2019-28

Commodity	Reference (recession) scenario	Sustained growth scenario	Change from reference (percent)
	Producer price (2010 BRL/ton)		
Beef	10,408.5	10,520.5	1.1
Corn	251.3	259.4	3.2
Cotton	3,497.3	3,578.4	2.3
Ethanol[1]	96.0	96.1	0.1
Pork	2,608.1	2,695.9	3.4
Poultry	1,793.6	1,818.0	1.4
Rice	486.2	499.7	2.8
Soybeans	621.4	639.2	2.9
Sugar	535.5	543.3	1.5
Sugarcane	69.1	70.3	1.8
Wheat	390.3	401.2	2.8
	Area harvested (1,000 hectares)		
Corn	19.4	19.6	0.8
Cotton	1.2	1.2	0.4
Rice	2.1	2.1	0.1
Soybeans	41.0	41.2	0.3
Sugarcane	10.3	10.3	0.2
Wheat	2.2	2.2	1.2
	Production (million tons)		
Beef	11.0	11.0	0.5
Corn	114.0	115.2	1.1
Cotton	2.1	2.2	0.8
Ethanol[1]	35.6	35.5	-0.1
Pork	4.1	4.1	-0.2
Poultry	16.7	17.6	5.4
Rice	8.4	8.4	0.2
Soybeans	138.7	139.2	0.4
Sugar	43.5	44.0	1.0
Sugarcane	782.4	784.0	0.2
Wheat	6.0	6.1	1.5
	Exports (million tons)		
Beef	2.5	2.3	-7.7
Corn	39.5	38.6	-2.3
Cotton	1.5	1.4	-0.9
Ethanol[2]	1.3	1.2	-7.7
Pork	1.0	0.9	-7.3
Poultry	5.5	5.7	2.3
Rice	1.1	1.1	0.1
Soybeans	80.2	80.1	-0.1
Sugar	32.2	32.6	1.0
Wheat	0.8	0.8	1.4

Note: BRL=Brazilian real.

[1]The ethanol price is per 100 liters. [2]Ethanol production and exports are in billion liters.

Source: USDA, Economic Research Service research results.

With marginal changes in sugarcane area, sugarcane production is 15.7 million metric tons higher than in the reference scenario in 2019-28. However, an increase in the share of sugarcane milled for sugar in response to rising international sugar prices (an increase of 1.9 percent per year through 2028) reduces Brazilian production of ethanol by 0.1 percent per year. Production of both hydrous ethanol (ethanol fuel, used in flex-fuel vehicles that run on gasoline-ethanol blends) and anhydrous ethanol (used as an additive to blend with gasoline) is sufficient to meet the 27-percent required blending rate (requiring an additional 35.5 billion liters in 2019-28) demand for fuel ethanol only, and export demand of an additional 1.2 billion liters in 2019-28.

In the sustained growth scenario, increases in production coupled with higher domestic consumption result in lower exports of soybeans, corn, cotton, soybean meal, ethanol, beef, and pork, thereby increasing world prices compared with the reference scenario (tables 14 and 15). In contrast, increased exports of sugar, soybean oil, and poultry lead to declines in their world prices ranging between 4 and 9 percent. Brazil is the world's largest exporter of sugar (45 percent of the global export market), so an increase in Brazilian sugar exports leads to an average decline of $4.27 per ton in world sugar prices over 2019-28.

Table 15
Change in world prices under the sustained growth scenario, 2019-28 average

	Percent	2010 USD/ton
Beef	1.9	18
Corn	0.3	*
Cotton	0.2	2
Pork	1.1	13
Poultry	-0.6	-9
Rice	0.1	*
Soybean meal	0.6	2
Soybean oil	-1.1	-8
Soybeans	*	*
Sugar	-0.9	-4
Wheat	0.2	*

Note: * = changes of less than 0.1 percent, USD=U.S. dollar.

Source: USDA, Economic Research Service research results.

With a reduction in ethanol production in the sustained growth scenario, Brazil's sugar production and exports increase at an annual average rate of 1 percent during 2019-28 (table 14), but annual ethanol exports decline by nearly 1 million liters. The increase in Brazilian sugar exports is mostly offset by declines in sugar exports from Australia and Ukraine (table 16).

The decline in soybean exports under the sustained growth scenario is marginal (averaging 0.1 percent lower over 2019-28), so faster growth in Brazil during its 2014-16 recession and into the future would not have changed the country's status as the world's largest soybean exporter. With higher domestic corn feed demand (up an average of 3.3 percent), Brazilian corn exports fall by an average of 2.3 percent in 2019-28 in the sustained growth scenario. This reduction in exports is partially offset by increased exports by the United States (up an average 1.3 percent) and by Argentina and Ukraine (both up 0.2 percent) (table 16).

Table 16

Change in exports under the sustained growth scenario versus reference (recession) scenario, 2019-28 average

	Beef	Corn	Cotton	Pork	Poultry	Rice	Soybeans	Sugar	Wheat
	1,000 metric tons								
Argentina	23.1	58.5	-0.4	0.0	-3.8	0.3	46.0	--	-19.0
Australia	-0.4	--	-0.3	0.6	-3.5	0.1	--	-20.9	-2.7
Brazil	-190.8	-925.6	-12.9	-69.3	130.3	0.1	-82.0	336.3	11.0
Canada	9.0	0.0	--	5.4	0.0	--	-0.7	0.0	-5.9
European Union	-0.1	0.0	0.0	11.5	-5.1	0.0	0.0	--	10.1
India	16.3	0.0	1.4	--	0.0	0.6	-0.2	-0.5	0.7
Russia	0.0	7.6	--	0.0	0.0	0.0	0.0	--	1.0
Ukraine	0.2	41.9	0.0	0.1	-0.8	0.0	3.1	-6.1	14.1
United States	4.3	664.7	5.4	3.9	-6.4	-6.8	-23.1	--	-21.4
	Percent								
Argentina	4.8	0.2	-0.4	0.0	-1.7	0.1	0.4	--	-0.1
Australia	0.0	--	0.0	1.2	-7.0	0.1	--	-0.5	0.0
Brazil	-7.7	-2.3	-0.9	-7.3	2.3	0.1	-0.1	1.0	1.4
Canada	2.1	0.0	--	0.4	0.0	--	0.0	0.0	0.0
European Union	0.0	0.0	0.0	0.4	-0.4	0.0	0.0	--	0.0
India	0.8	0.0	0.1	--	0.4	0.6	-0.1	-0.1	1.6
Russia	0.0	0.1	--	0.0	0.0	0.0	0.0	0.0	0.0
Ukraine	0.3	0.2	0.0	2.0	--	--	0.1	-0.5	0.1
United States	0.3	1.3	0.2	0.1	-0.2	-0.2	0.0	--	-0.1

Note: -- = not applicable.

Source: USDA, Economic Research Service research results.

Conclusion

Macroeconomic policies have contributed to Brazil's growing agricultural output and its emergence as a competitor for the United States in global agricultural markets, despite experiencing a recession and economic contraction. Public investments in agricultural research and credit have had an important role on the dynamic competitiveness of Brazilian agriculture. However, income growth (at home and abroad) and exchange rates have been major factors in the expansion of Brazil's agricultural production and exports.

Since the early 2000s, robust income gains boosted domestic demand while global income growth, particularly in China and other developing countries, boosted import demand for Brazilian foods, feeds, and fibers. Extended periods of depreciation of the BRL have supported the increasing competitiveness of Brazilian exports. Other factors, including declining oil and other commodity prices, higher interest rates, rising demand for biofuels feedstocks, and changes in the macroeconomic conditions for Brazilian markets and competitors, also contributed to changes in the country's agricultural markets.

Volatility in Brazil's exchange rate and its economic growth can potentially influence global agricultural exports by influencing the prices of its exports and its domestic demand for commodities. Brazil's growing share of export markets in recent years and declining world prices for many commodities coincided with depreciation in the country's currency against the U.S. dollar and one of Brazil's deepest recessions during 2014-16. Brazil's continued macroeconomic uncertainty and growth in its share of China's and other countries' imports of soybeans and other agricultural commodities could have on-going implications for global markets.

This study investigated the role of Brazilian exchange rate fluctuations and economic growth by simulating impacts of alternative counterfactual scenarios using the ERS partial equilibrium model that USDA uses to project global agricultural supply and demand. One scenario featured accelerated depreciation of Brazil's currency, the *real* (BRL). In the sustained growth scenario, Brazil avoided the 2014-16 recession, enabling it to maintain its expected path of macroeconomic growth through 2028. The simulations show Brazil's production, use, and exports of major commodities under these scenarios, with comparisons to USDA's 2028 baseline projections (released in 2018). Changes in global exports, imports, and prices were also assessed.

The simulations suggest that depreciation of the Brazilian BRL has a stronger impact on Brazil's exports than does more robust economic growth. Depreciation of Brazil's currency encourages production, expansion of crop area, and helps the country capture additional shares of international soybean and corn markets. In addition, devaluation depresses the international prices of commodities that Brazil exports.

Stronger domestic income growth in Brazil encourages greater meat and feed grain consumption in the country. The sustained growth scenario shows that Brazil might have reduced its beef exports and reduced corn exports marginally, but its status as the top soybean exporter would have been unaffected if it had avoided recession during 2014-16 and continued to grow rapidly through 2028. The largest changes are for corn output and exports, due to feed demand domestically and abroad. The results show that the direction of Brazil's exchange rate will be an important determinant of its export competitiveness. Since Brazil is an important player in the international market, U.S. farmers

producing competing products may face stiffer competition for import markets, potentially resulting in declining product prices and decreased U.S. commodity exports under these simulations.

Devaluation of Brazil's currency stimulates Brazilian production of export-oriented crops and livestock products. Increased revenues for farmers in domestic currency from a weaker Brazilian BRL outweigh increases in cost of imported inputs for all major commodities except sugarcane, thus raising net returns and encouraging greater output and exports. The large proportion of sugarcane used for ethanol production results in a different outcome for that crop. A weaker currency results in lower imports of fuel, encouraging more use of sugar for domestic ethanol production.

Brazil still has untapped potential in agricultural production and trade. Further gains in output are expected as even more land comes under cultivation. Only an estimated 25 percent of the *Cerrados* is cultivated, and Brazil's Ministry of Agriculture estimates that an additional 120 million hectares could come under crop production (USDA, FAS, 2019b). To mitigate infrastructure bottlenecks, the Brazilian Government relieved congestion and expedited transportation by constructing roads, railways, and waterways to ports. At the farm level, technical change is expected as well. In recent years, legal constraints against using genetically modified (GM) seeds have been relaxed, and Brazilian growers have been increasing their use of GM and other high-yielding varieties. With its wide expanse of untapped area suitable for cultivation, Brazil's agricultural production growth is expected to outpace gains in global agricultural production and consumption (USDA/OCE, 2019).

These findings suggest that a larger and more export-oriented Brazilian agricultural sector emerged from the country's recent recession, despite significant challenges such as lower credit availability, high interest rates, and higher fertilizer costs. The combined actions of Brazilian farmers, Government support, and agricultural and macroeconomic policies during the recession led to cropland expansion and positive changes to factors underlying production and marketing costs, further enhancing Brazil's export competitiveness.

The recession affected Brazilian agriculture on three main fronts: production costs, commodity prices, and economic returns. At the same time, Brazilian Government programs that were beneficial to agricultural production, macroeconomic policies that lowered interest rates, reduced tariffs for critical inputs, and the devaluation of the currency contributed to lowering on-farm production costs. This helped make Brazil a more competitive exporter of soybeans, grains, and meats over the past 5 years, despite the recession. Increased credit availability at subsidized rates and expansion in transportation infrastructure led to an expansion in cropland and lower production and export costs. The devaluation of the BRL during the recession increased the competitiveness of Brazilian exports during the period.

Further shifts in production patterns, increased use of new technologies, increased investments in production agriculture and agro-food industries, and infrastructure developments are likely to occur over the next few years. Brazilian exports are likely to continue to grow significantly, particularly if rising demand from China siphons Brazilian agricultural supplies from other exporters, including the United States. Large areas of uncultivated agricultural land remain, which, when coupled with research investments in technology advances, could result in continued improvements in productivity and yields in many agricultural sectors. This would increase the sector's ability to grasp export opportunities presented by the rising demand for feedstuffs in world markets (USDA/OCE, 2019).

Future Brazilian agricultural export growth is tied closely to worldwide economic growth. Projected long-term global trend growth leads to increasing demand for Brazilian commodities, and with higher domestic economic incentives for expansion of the sector, Brazil is expected to continue increasing its agricultural competitiveness over the next decade. However, the impact of the 2020 domestic and global lockdowns and financial turmoil could drive the Brazilian economy into a new severe recession. The net effect of policy-driven measures to revive the economy and devalue the currency further may be countered by reduced global demand, a situation much different from the one experienced during the 2014-16 Brazilian recession.

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Appendix - A Model of Brazilian Agriculture and the Country-Commodity Linked System (CCLS)

The Brazil model is a dynamic partial equilibrium agriculture sector model covering supply, use, prices, and policies for 27 commodities including wheat, rice, corn, sorghum, barley, other coarse grains, soybeans and their products, other oilseeds and their products, cotton, sugar, ethanol, beef, pork, poultry, milk and eggs markets. The model also includes assumptions of key macroeconomic variables (income, population, interest rates, and exchange rates), petroleum and fertilizer prices, trade policies (import tariffs), government policies, production technology, and input prices. The model takes market-clearing world prices as given, both in the historical and projected years. The world prices feed into determination of Brazil's commodity prices, which in turn generate, for 10 or more years into the future, supply and demand balances for modeled commodities.

The stock and use of land for growing crops and rearing livestock is also modeled. Cattle inventories are constrained by stocking rates and the share of pasture that is degraded. The quantity of land available for temporary crops is constrained by that devoted to permanent crops, minimum fallow requirements, and limits on multiple cropping. In the Brazil model, the production of corn, soybeans, and sugarcane, as well as cattle inventories and pasture land, are modeled regionally. Land allocated to crops depends on the expected costs of producing alternative crops relative to the expected revenue for each crop. Expected costs include direct energy-related inputs, such as fuel, and indirect energy-related costs, such as fertilizer. Regional fertilizer costs for corn, soybeans, sugarcane, and pasture are projected from national average urea, phosphate, and potash fertilizer prices, which are determined by world petroleum prices. Energy-related production costs for other crops are projected directly from world petroleum prices.

The Brazil model is incorporated into the Country-Commodity Linked System (CCLS) (Hjort et al., 2018). The system combines 42 country or region models that determine equilibrium prices and trade to simultaneously clear 24 agricultural commodity markets. The model can be used to project the outcome of scenarios 10 years into the future. The Brazil model and other stand-alone country and regional models in the CCLS take market-clearing world prices as given, both in the historical and projected years. World market-clearing prices are determined by the interaction of country-specific agricultural and trade policies, producer responses to changes in production incentives, and consumer demands for commodities, which yield export supply and import demand. World prices change, generating changes in commodity prices in each country/region, until world export supplies and world import demand are equal.

The commodity markets cleared include feed grains (corn, sorghum, barley, and other coarse grains); food grains (wheat and rice); oilseeds and products (soybeans, rapeseed, other oilseeds, and the corresponding meals and oils); other crops (cotton and sugar); and animal products (beef and veal, pork, poultry, and eggs). Major exporting countries/regions covered are Argentina, Australia, Brazil, Canada, China, the European Union, India, Russia, Ukraine, the United States, and Southeast Asian rice exporters. Major importing countries/regions include Egypt, Hong Kong, Japan, Korea, and Taiwan, plus regional blocs such as the Economic Community of West Africa. In the Linker System, these countries respond to Brazilian market changes.