Impacts of the Chinese Fuel-Ethanol Program on the World Corn Market: An Econometric Simulation Approach

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Farm Foundation and ERS Workshop Global Biofuel Developments: Modeling the Effects on Agriculture, February 27, 2007
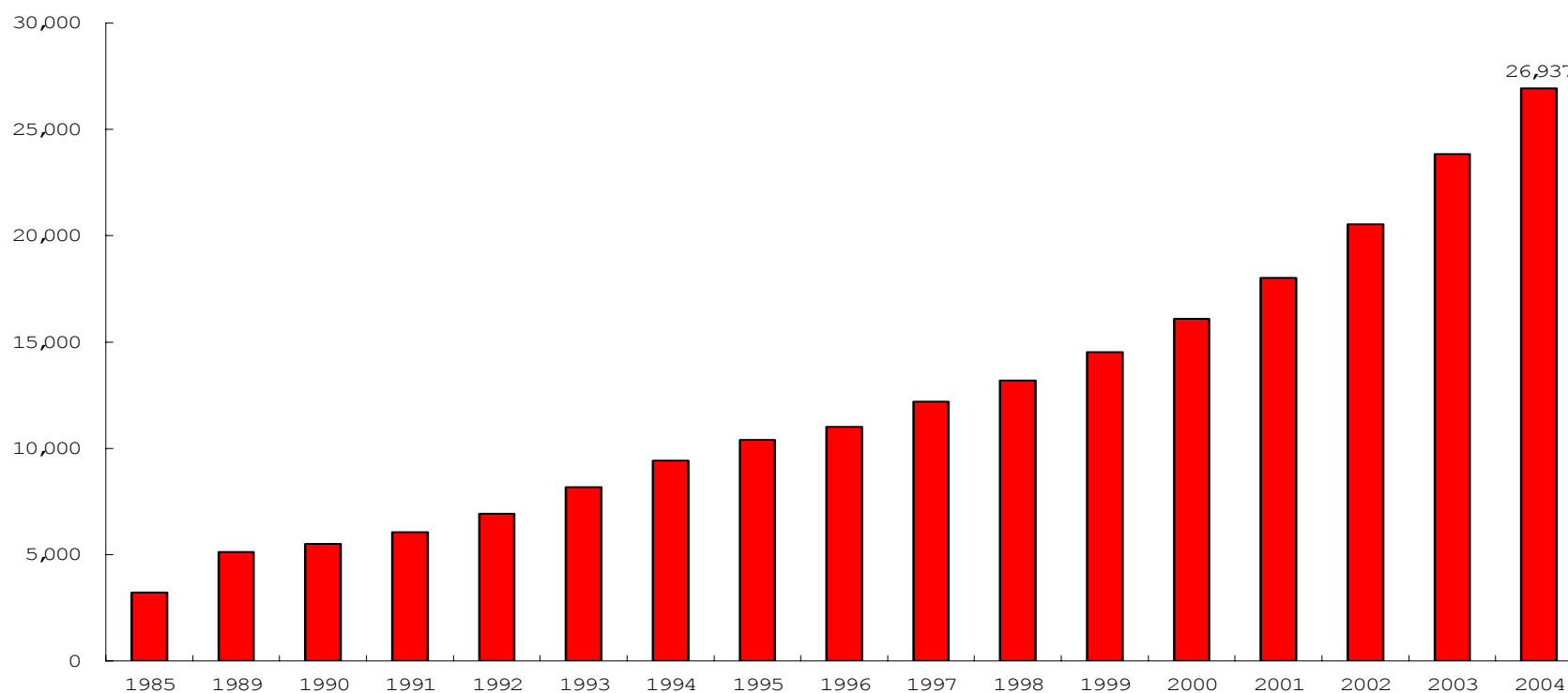
Purpose of this Study

Evaluate how Chinese fuel-ethanol programs will affect the world corn market

Based on a newly developed world corn market model

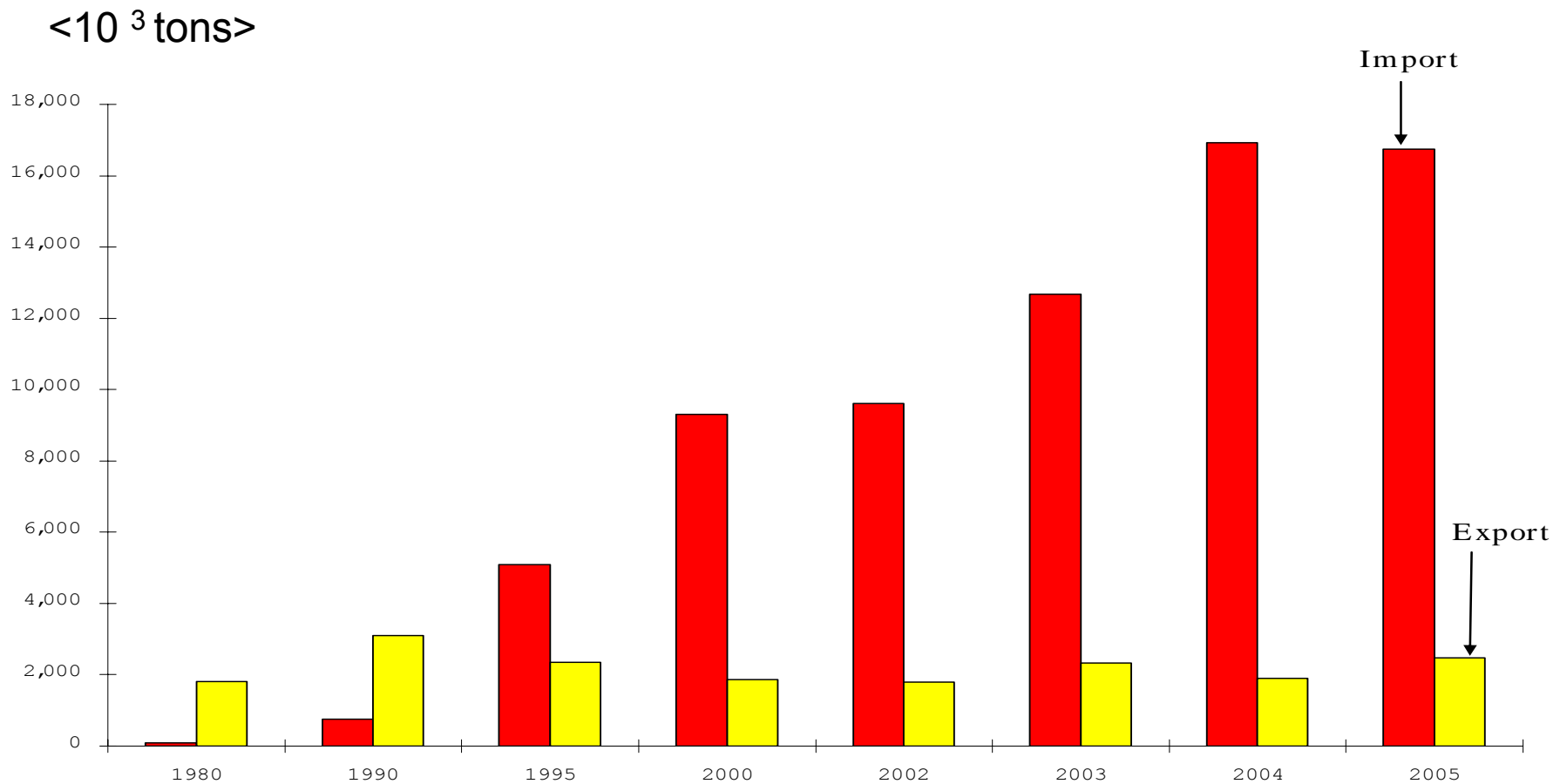# The number of automobile in china is increasing

<10^3 Cars>

Source: China Statistical Yearbook 2005

Chinese petroleum consumption is increasing and its import of crude oil and oil products are rising too

$<10^3 \text{ tons}>$

Source: China Statistical Yearbook 2005

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The increase in petroleum consumption is causing serious air pollution problems

In order to deal with energy security and the air pollution problem, the Chinese government is strongly promoting the National Fuel- ethanol program

In June 2002, the government started to make the use of fuel-ethanol blended gasoline mandatory

Chinese Fuel-Ethanol Program
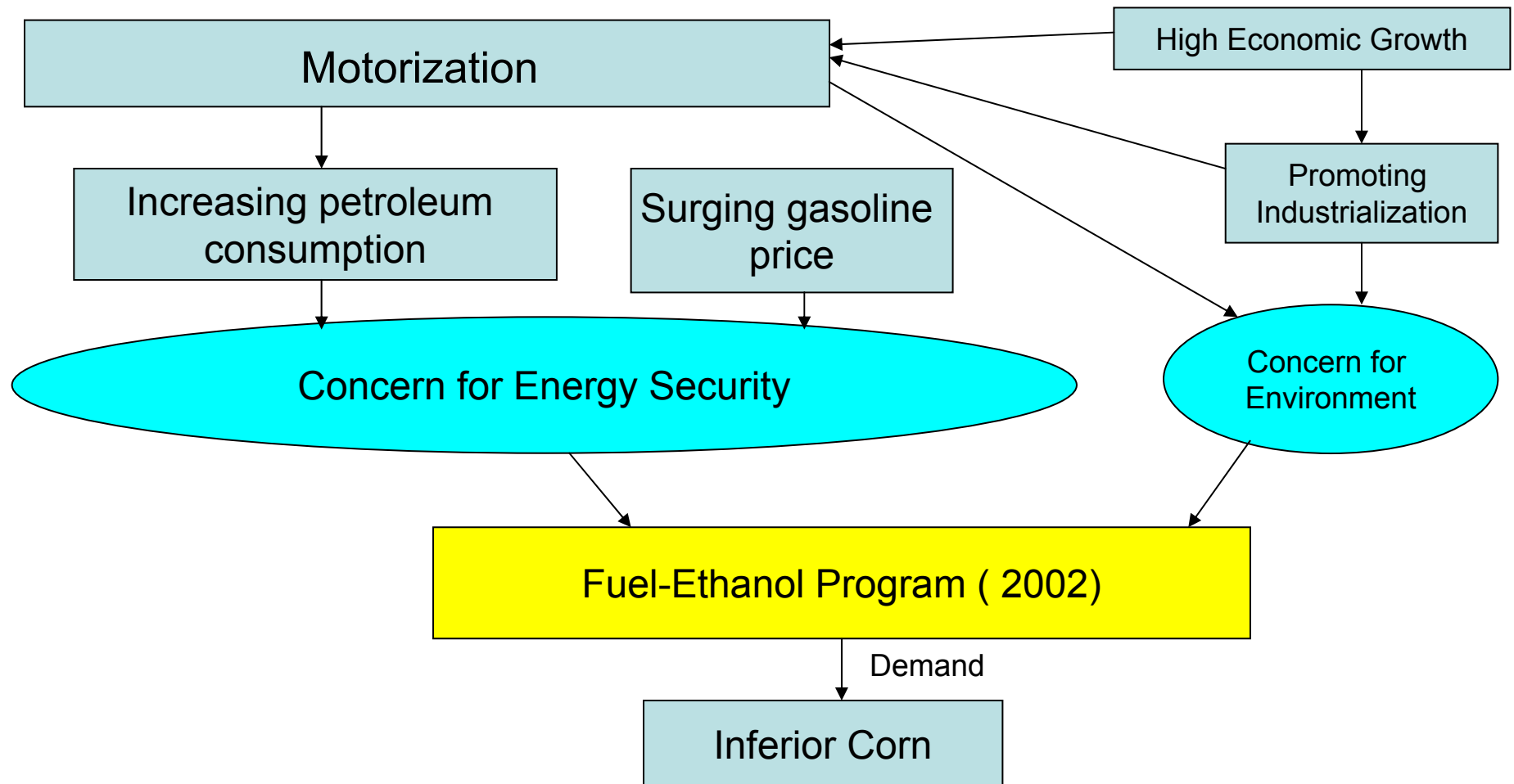
The Chinese Fuel-Ethanol Program

In 2004, the government introduced the compulsory use of a 10% bio-ethanol blended gasoline (E10) in provinces of Helongjiang, Jilin, Liaoning, Henan, and Anhui

The government expands the E10 program to 27 cities in the provinces of Shandong, Jiangsu, Hebei, and Hubei in 2006

Fuel-Ethanol Production Sites

China Resources
Alcohol Co, Heilongjang
(Corn)

China Resources
Alcohol Co, Hebei
(From 2007: Sweat
potato, corn etc)

Jilin Fuel Ethanol
Co, Jilin (Corn)

Henan Tian
Guan Fuel-
Ethanol Co,
Henan (Wheat)

China Resources Alcohol
Co, Guangxi (From 2007,
Cassava)

Anhui BBCA
Biochemical
Co. (Corn)

Source: Law Concerning Testing of the Extensive Use of Ethanol-Blended
Gasoline for Automobiles and Regulations Concerning the Conduct of
Testing of the Extensive Use of Ethanol-Blended Gasoline for
Automobiles (2006)

Tian Guan Fuel-Ethanol
Co.Hubei (From 2007,
Grains)

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Corn is the major source of fuel-ethanol in China

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1) Corn

   80 % of fuel-ethanol is made from corn in China

   Ethanol facilities in Heilongjiang, Jilin, and Anhui use corn

2) Wheat

   Wheat is used in Henan

3)   Cassava

  - The Guagxi Zhuang autonomous region plans to build a fuel-ethanol plant
  - The plant is scheduled to begin operations in October of 2007 at a production capacity of 110,000 MT

4)   Others
   Potato, sorghum, rice, sugar, and lignocellulose are on experimental stage for fuel-ethanol production

Chinese fuel-ethanol production cost and agricultural production

Production(10^3 tons)

Production cost (Yuan/ton)
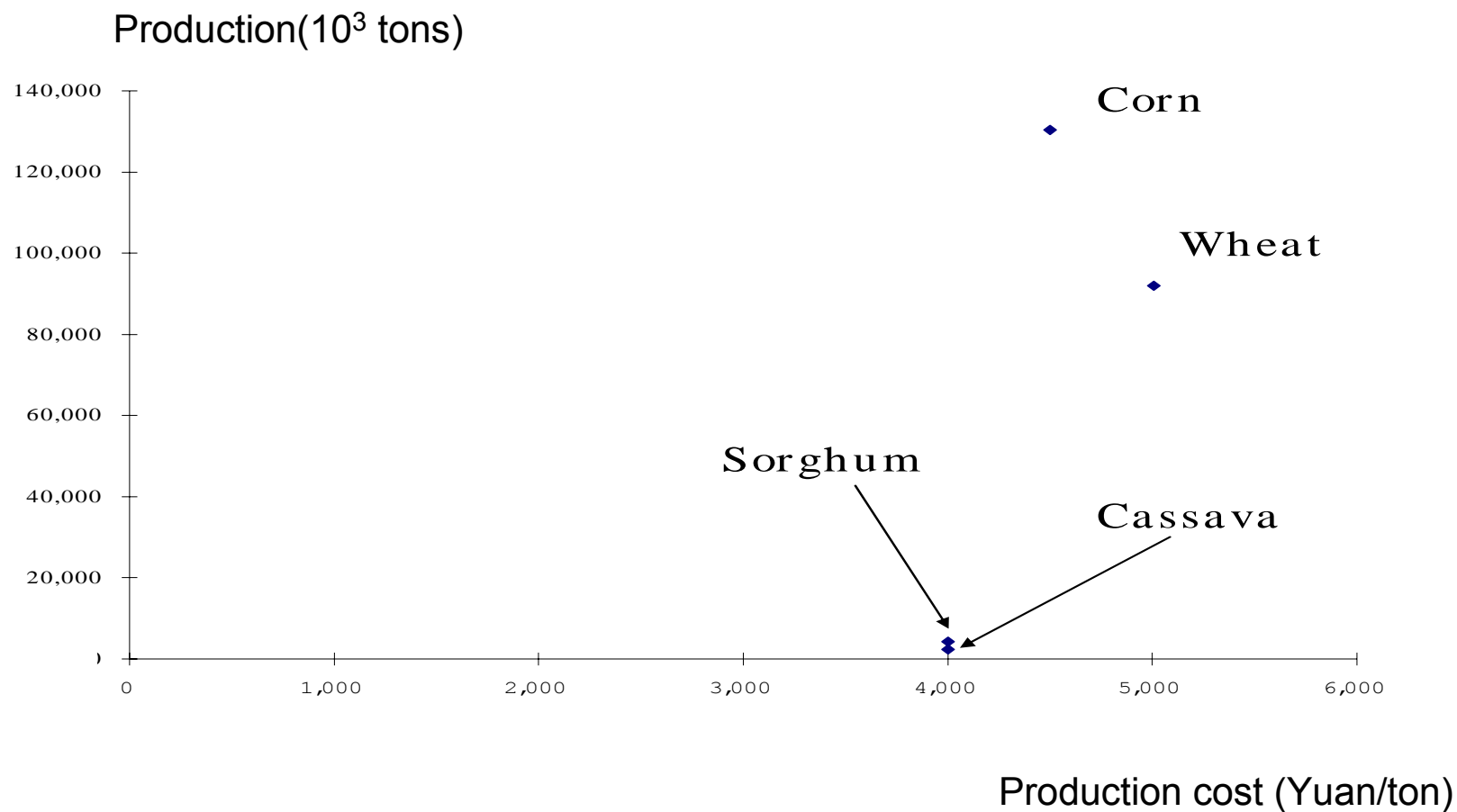
Note: Production data is derived from FAS, USDA, PS&D (2006)

Production cost is derived from the Chinese National Development and Reform Commission

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Corn use for Fuel-Ethanol production

Although Chinese central government ordered to use inferior corn for fuel-ethanol production, facilities in Heilongjiang and Jilin use normal corn

If China continues to expand corn-based fuel-ethanol production, corn utilization ratio for ethanol will increase

The world corn market model

The world corn market model is a dynamic partial equilibrium model

The model covers 11 major countries and regions (China, U.S., Argentina, Brazil, South Africa, Japan, Canada, EU25, Mexico, the Korean Republic and the Rest of the World)

The model simulates production, consumption, export, import, and ending stocks to the year 2014/15

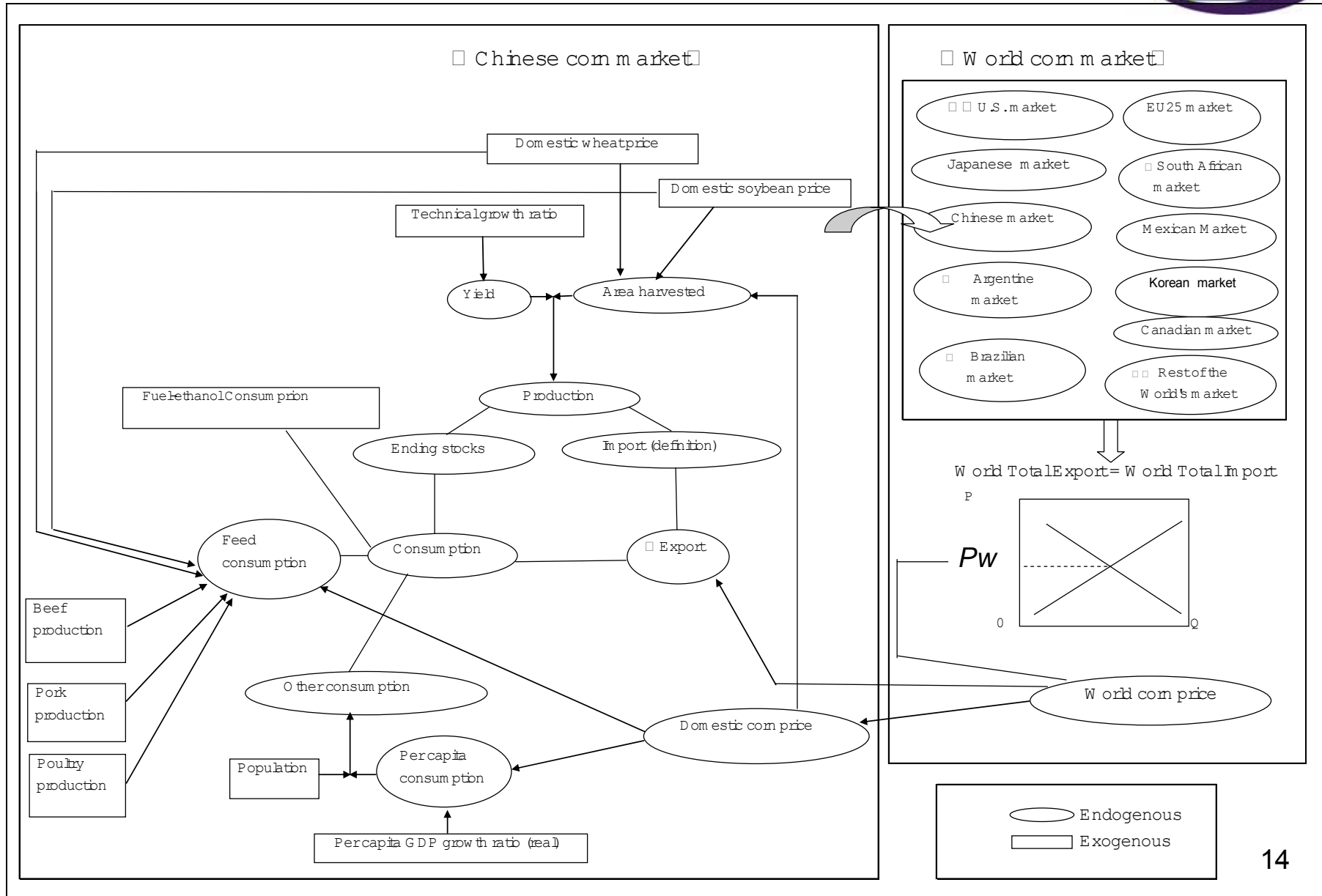For each simulation year, the model determine gross exports and imports for each country and region

A world corn market equilibrium price is obtained from equilibrium

conditions through the use of the Gauss-Seidel algorithm

World corn price (Corn No.2 yellow, Chicago) refers to the world corn market clearing price

Wheat price, soybean price, beef production, pork production and dairy production were exogenous variables

Structures of the world corn model

Chinese corn market

- Domestic wheat price
- Domestic soybean price
- Technical growth ratio
- Yield
- Area harvested
- Fuel ethanol Consumption
- Production
- Ending stocks
- Import (definition)
- Feed consumption
- Consumption
- Export
- Beef production
- Pork production
- Poultry production
- Other consumption
- Population
- Per capita consumption
- Domestic corn price
- Per capita GDP growth ratio (real)

World corn market

- U.S. market
- EU25 market
- Japanese market
- South African market
- Chinese market
- Mexican Market
- Argentine market
- Korean market
- Canadian market
- Brazilian market
- Rest of the World's market

World Total Export = World Total Import

P

Pw

0   Q

World corn price

Endogenous
Exogenous

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Baseline Assumptions in general

The current agricultural policy will be continued in all countries

Normal weather and historical rates of technological innovation are taken for granted

Baseline Assumptions China specific

Chinese government will maintain and promote the E10 program
in Heilongjiang, Jilin, Liaoning, Henan and Anhui from 2005

Shandong, Jiangsu, Hebei, and Hubei are assumed to start the
E10 program in 27 cities from 2006

Ethanol facilities in Helongjiang and Jilin use corn

Chinese corn consumption for fuel-ethanol is projected to increase from 2,363 thousand MT in 2004/05 to 4,317 thousand MT in 2014/15

Chinese corn consumption for fuel-ethanol (Baseline projection)

(10³ tons)

	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Fuel-ethanol Consumption, Corn Equivalent: (1)*3.07	2,363.3	2,535.8	2,708.3	2,880.9	3,053.4	3,225.9	3,398.5	3,628.0	3,857.5	4,087.0	4,316.5
Fuel-ethanol Consumption : (1)=(2)+(3)+(4)	769.8	826.0	882.2	938.4	994.6	1,050.8	1,107.0	1,181.8	1,256.5	1,331.3	1,406.0
Fuel-ethanol consumption in Jilin (2)	126.2	135.4	144.6	153.8	163.0	172.3	181.5	193.7	206.0	218.2	230.5
Fuel-ethanol consumption in Heilongjiang (3)	336.4	361.0	385.5	410.1	434.7	459.2	483.8	516.5	549.1	581.8	614.5
Fuel-ethanol consumption in Liaoning (4)	307.2	329.6	352.0	374.5	396.9	419.3	441.7	471.6	501.4	531.2	561.1

(Source) Authors' estimate based on China Energy Statistical Yearbook (2004),

International Energy Outlook (2003)

Alternative scenario

Shandong, Jiangsu, Hebei, and Hubei will start the E10 program
from 2007/08. As a result of this new program, the nine provinces are
assumed to promote the fuel-ethanol program at the provincial level
from 2007/08

As a result of the expanded program, corn consumption for fuel-
ethanol is predicted to increase from 6,240 thousand MT in 2007/08 to
9,946 thousand MT in 2014/15

# Chinese corn consumption for fuel-ethanol (Alternative Scenario)

(1000 tons)

	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Fuel-ethanol consumption, corn equivalent: (1)*3.07	6,240.0	6,685.4	7,130.8	7,576.3	8,168.8	8,761.3	9,353.8	9,946.3
Fuel-ethnaol consumption (1)=(2)+(3)	2,032.6	2,177.7	2,322.7	2,467.8	2,660.8	2,853.8	3,046.8	3,239.8
Fuel-ethanol consumption (Baseline) (2)	938.4	994.6	1,050.8	1,107.0	1,181.8	1,256.5	1,331.3	1,406.0
Additional Fuel-ethanol consumption (From maize): (3)=(5)-(4)	1,094.2	1,183.1	1,272.0	1,360.8	1,479.1	1,597.3	1,715.6	1,833.8
Fuel-ethanol consumption (from wheat) (4)	390.0	390.0	390.0	390.0	390.0	390.0	390.0	390.0
4 Province Total: (5)=(6)+(7)+(8)+(9)	1,484.2	1,573.1	1,662.0	1,750.8	1,869.1	1,987.3	2,105.6	2,223.8
Fuel-ethanol consumption in Hebei (6)	369.2	391.3	413.4	435.5	464.9	494.4	523.8	553.2
Fuel-ethanol consumption in Shandong (7)	280.5	297.3	314.1	330.8	353.2	375.5	397.9	420.2
Fuel-ethanol consumption in Hubai (8)	369.2	391.3	413.4	435.5	464.9	494.4	523.8	553.2
Fuel-ethanol consumption in Jiangsu (9)	465.3	493.2	521.1	548.9	586.0	623.1	660.1	697.2

(Source) Authors' estimate based on China Energy Statistical Yearbook (2004) and International Energy Outlook (2003)
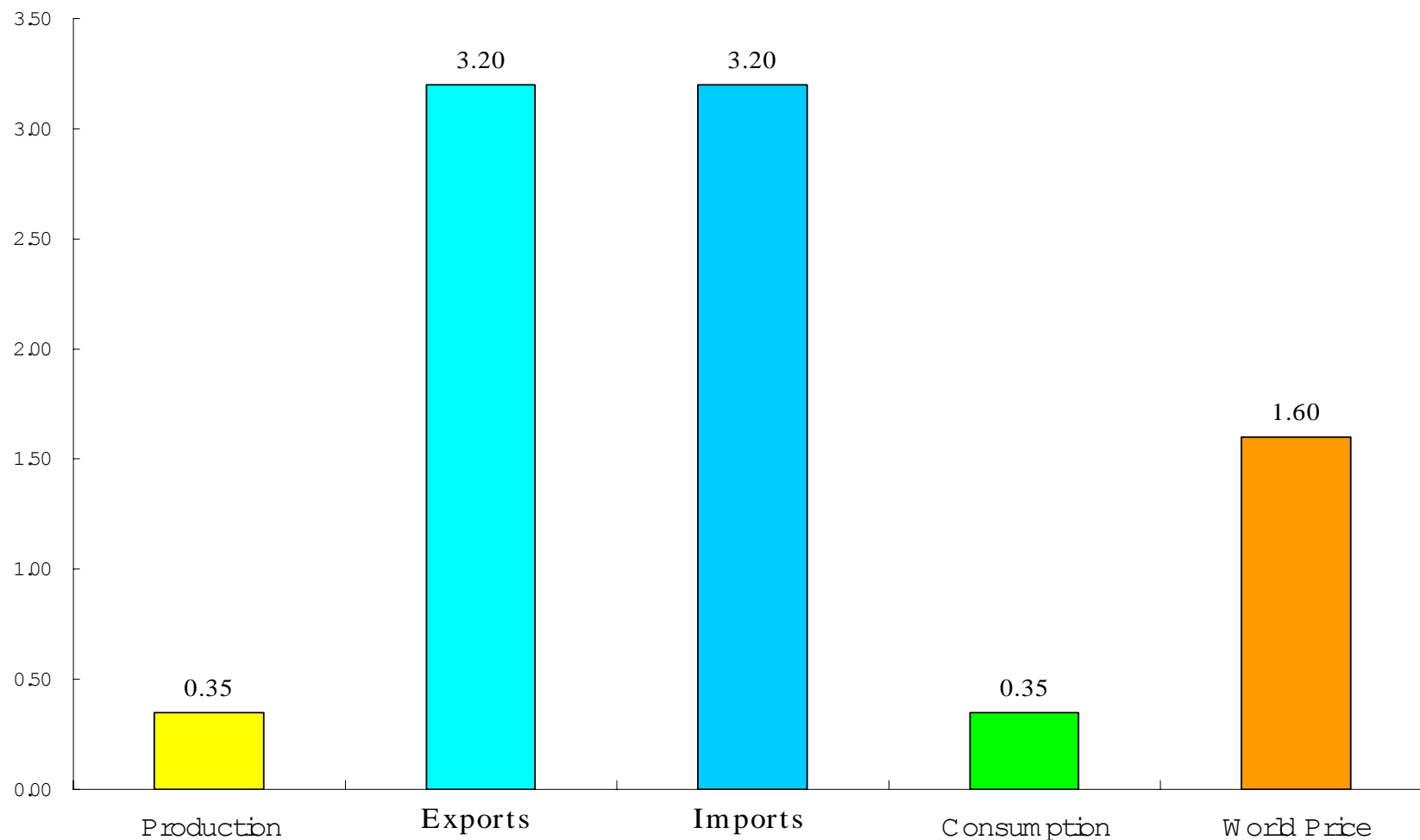
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Baseline projections
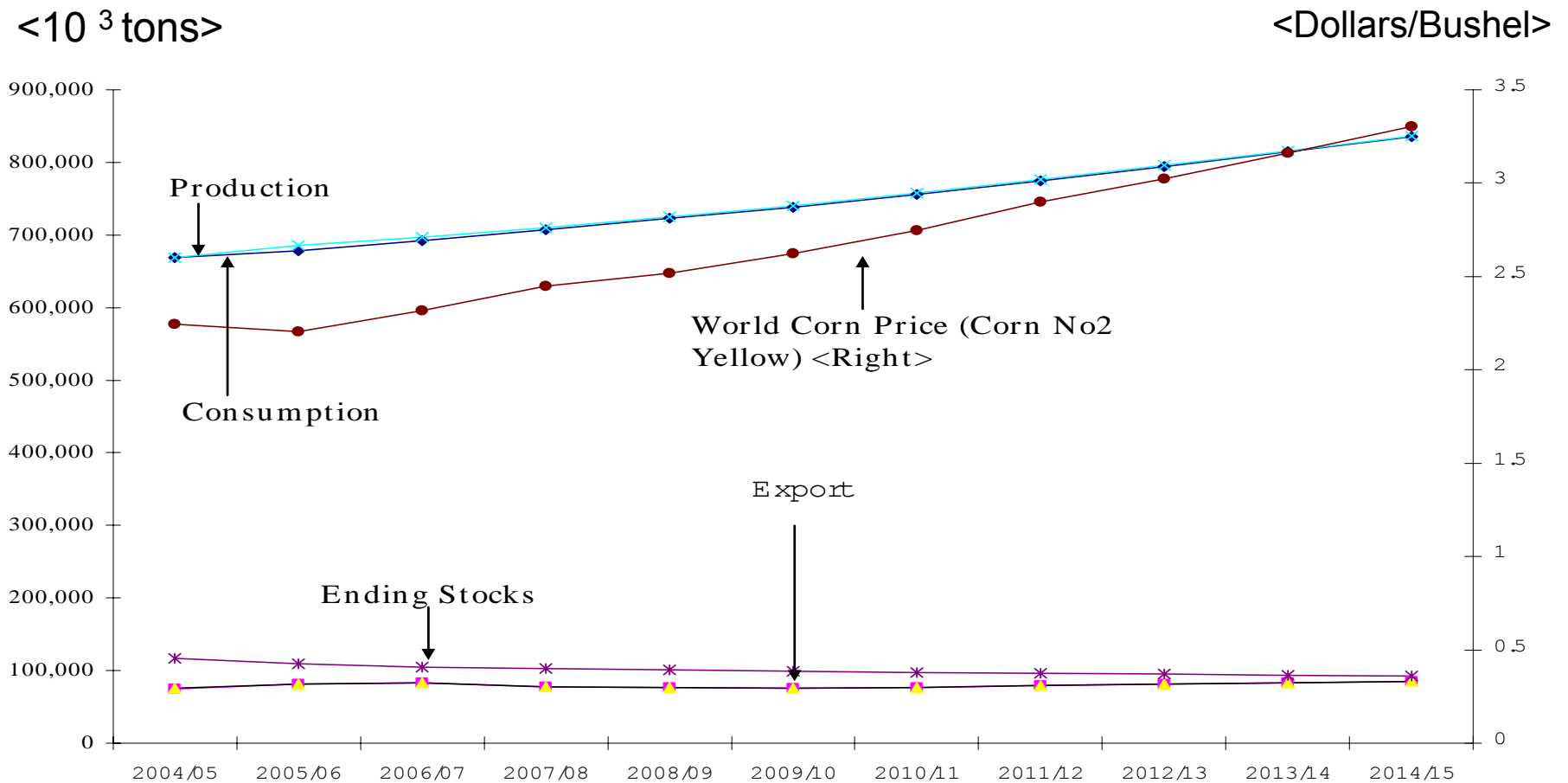
Impacts on the World Corn Market Scenario / Baseline : 2014/15)

(percent)

Note: Each percentage means "(Scenario(2014/15)/Baseline (2014/15)-1)*100"

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Conclusions

The Chinese expanded fuel-ethanol programs are predicted to affect the world corn market

Fuel-ethanol is competing with feed, food and others for the consumption of corn

Chinese central government stated to regulate corn-based fuel-ethanol production (Statement from National Development and Reform Commission in 21/12/2006)

Chinese government wants to diversify the sources of fuel-ethanol production

Future directions of this study

How DDGS (Distillers' Dried Grains with Solubles) will affect feed and livestock markets

How the fluctuation of the world crude oil price influences the world ethanol and corn markets

Special thanks to

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- Dr. Takeshi Sakurai, Senior Economist, Policy Research institute, Ministry of Agriculture, Forestry and Fisheries Japan

Impacts of Japanese Bio-Ethanol Import on the Brazilian and World Sugar Markets: An Econometric Simulation Approach

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** Professor, College of Bioresource Science, Nihon University

Purpose of this study

Evaluate how Japanese bio-ethanol import will affect on Brazilian and international sugar markets

Based on a newly developed world sugar market model

Japanese bio-ethanol Program (Background)

Preventing global warming

Development of strategic industries

Vitalization of rural and farming communities

Biomass Nippon Strategy was formulated in December 2002

Revised Biomass Nippon Strategy (Japan)

Kyoto Protocol was put into effect in February 2005

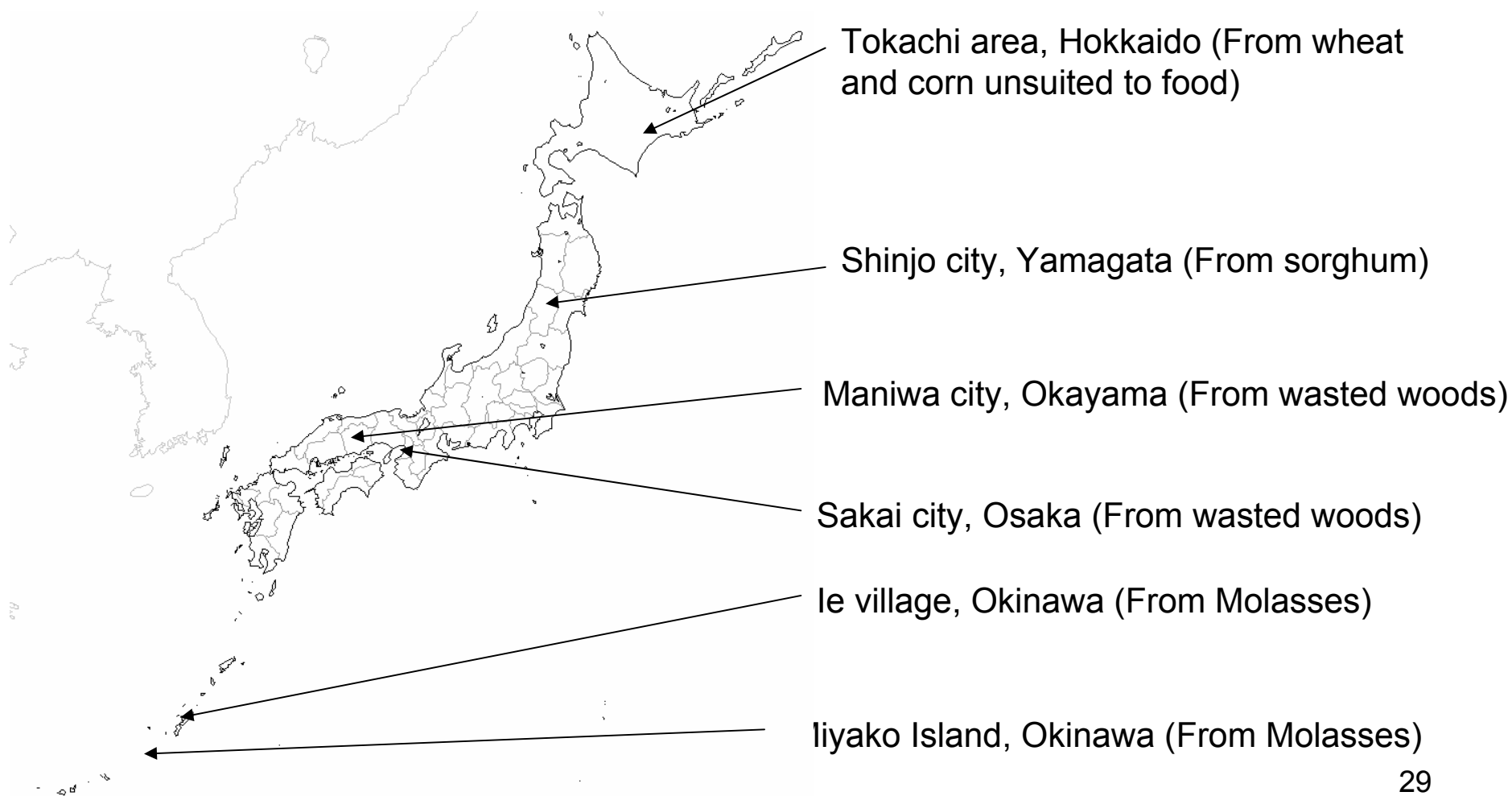Revised Biomass Nippon Strategy was formulated in March 2006

Promotion of utilization of biomass for transportation fuel, particularly of domestic biomass

Current Bio-Ethanol Production (Japan)

Japanese bio-ethanol production is at an experimental stage

Current production level is 30 kl (April 2006)

Tokachi area, Hokkaido (From wheat and corn unsuited to food)

Shinjo city, Yamagata (From sorghum)

Maniwa city, Okayama (From wasted woods)

Sakai city, Osaka (From wasted woods)

Ie village, Okinawa (From Molasses)

Iiyako Island, Okinawa (From Molasses)

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Expected Result (Japan)

Food and Agriculture

Reinforcement of international competitiveness to agriculture

Improvement and maintenance of food supplying capability

Environment

Contribution to fulfillment of the target dedicated by the Kyoto Protocol

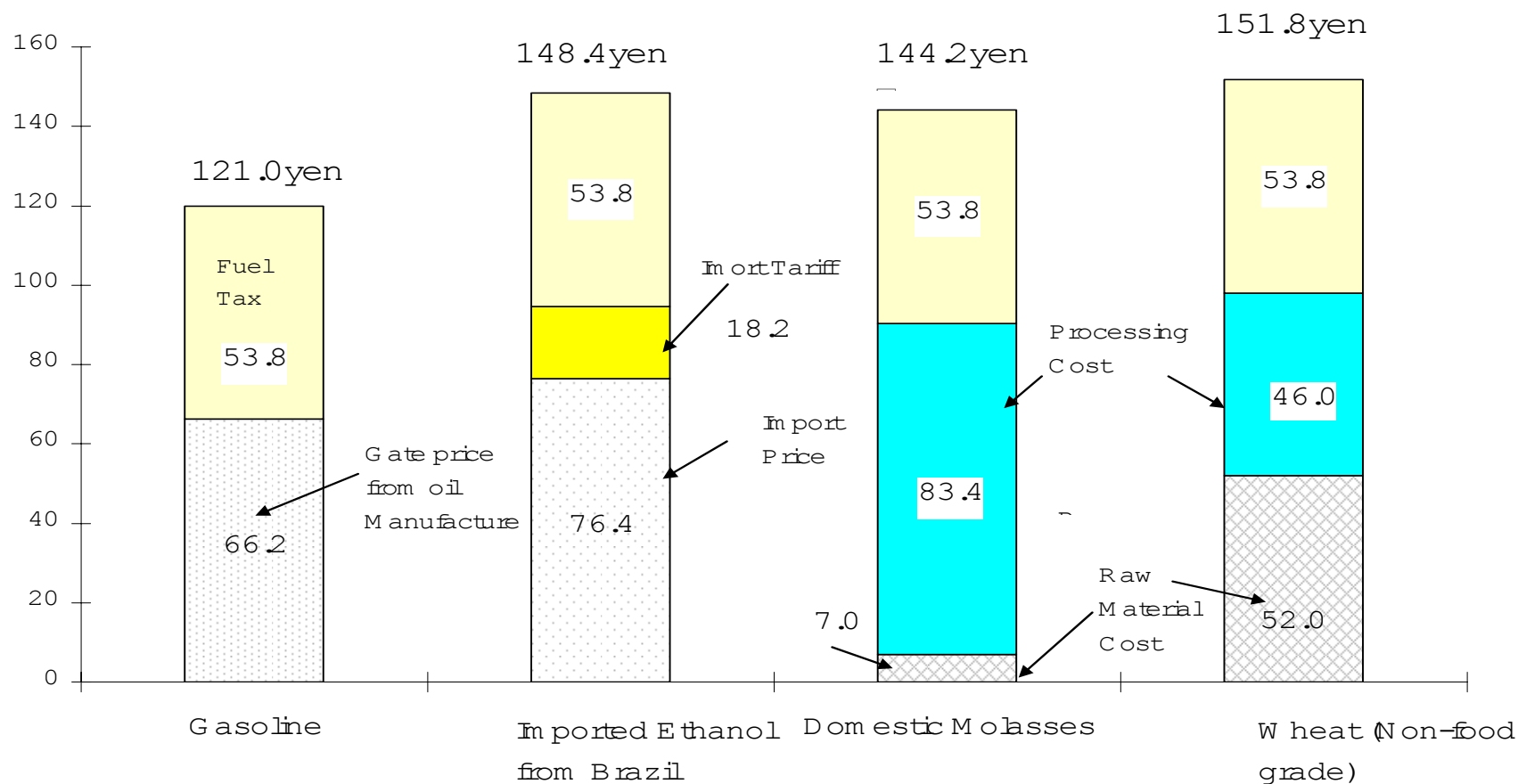Actions in consideration of Post-Protocol situation

Energy

Action to cope with rising crude oil price

Diversification of energy sources (energy security)

Production cost and fuel-tax need to be reduced to expand bio-ethanol production in Japan

Yen/Liters

Gasoline — 121.0yen
- Fuel Tax 53.8
- Gate price from oil Manufacture 66.2

Imported Ethanol from Brazil — 148.4yen
- 53.8
- Import Tariff 18.2
- Import Price 76.4

Domestic Molasses — 144.2yen
- 53.8
- Processing Cost 83.4
- Raw Material Cost 7.0

Wheat (Non-food grade) — 151.8yen
- 53.8
- 46.0
- 52.0

Domestic bio-ethanol or Imported bio-ethanol?

Japanese government permits to blend bio-ethanol in gasoline up to 3% by law

Japanese government promotes to utilize of bio-fuel, especially for bio-ethanol

Securing feedstock for bio-ethanol, reduction of production cost, tax reduction for bio-ethanol are needed to expand bio-ethanol production in Japan

Due to limitation of domestic bio-ethanol supply, there is an argument whether Japan should depend on imported bio-ethanol (from Brazil) or not

The world sugar market model

The world sugar market model is a dynamic partial equilibrium
model

The model covers 12 major countries and regions (Brazil, U.S.,EU15,
Australia, Mexico, Japan, India, China, ACP countries, Thailand,
Former USSR, and the Rest of the World.)

The model simulates production, consumption, export, import, and
ending stocks to the year 2015

For each simulation year, the model determine gross exports and imports for each country

A world sugar market equilibrium price is obtained from equilibrium conditions through the use of the Gauss-Seidel algorithm

World sugar price refers to the world sugar market clearing price

World white sugar price is linked to the world raw sugar price
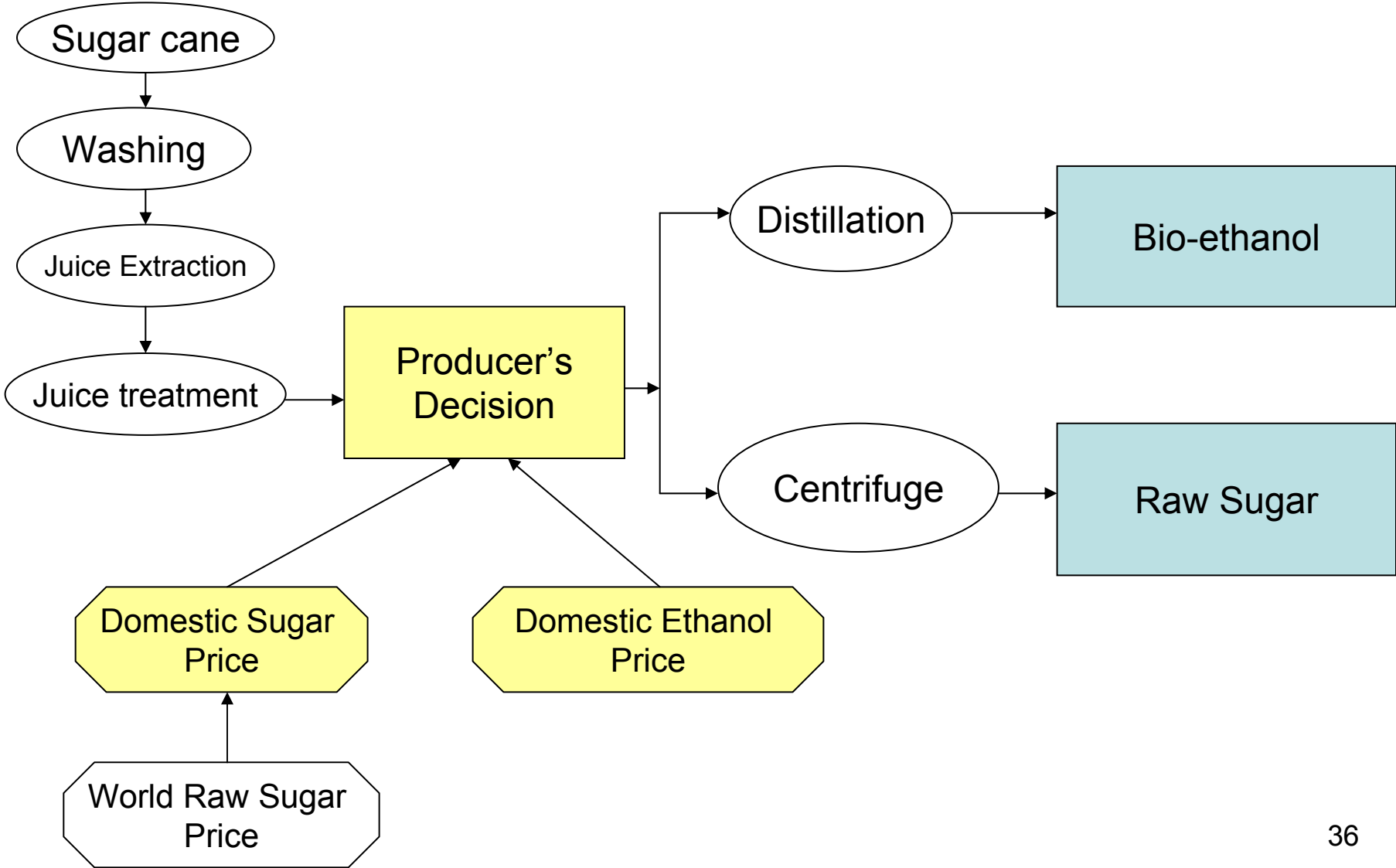
Corn and wheat price are exogenous variables

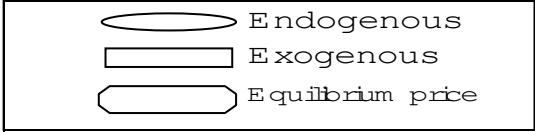In the model, sugar and bio-ethanol markets are linked together in Brazilian market
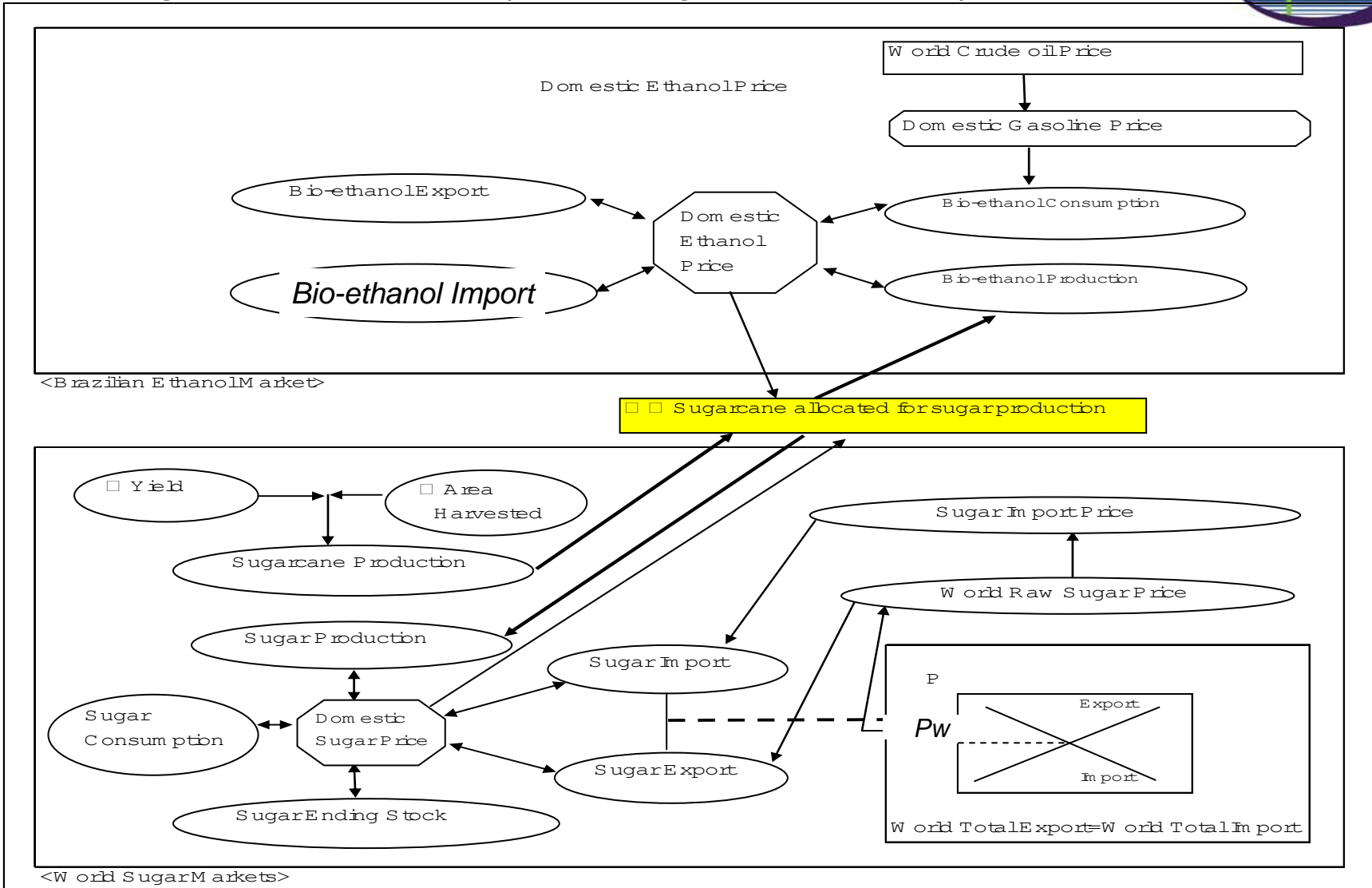
The main driving factor that determines the production levels of bio-ethanol and sugar is the relationship between the domestic sugar price and the domestic bio-ethanol price

In the Brazilian market, a *sugarcane allocation ratio variable* is defined as the relative proportions of sugarcane that go to bio-ethanol production and sugar production

Brazilian bio-ethanol and sugar production (Abstract)

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World Sugar Market Model (Raw Sugar Equivalent)

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Domestic Ethanol Price

World Crude oil Price

Domestic Gasoline Price

Bio-ethanol Export

Domestic Ethanol Price

Bio-ethanol Consumption

Bio-ethanol Import

Bio-ethanol Production

<Brazilian Ethanol Market>

Sugarcane allocated for sugar production

Yield

Area Harvested

Sugar Import Price

Sugarcane Production

World Raw Sugar Price

Sugar Production

Sugar Import

P

Sugar Consumption

Domestic Sugar Price

Export

Pw

Sugar Export

Import

Sugar Ending Stock

World Total Export=World Total Import

<World Sugar Markets>

Endogenous
Exogenous
Equilibrium price

Baseline scenario

The current agricultural policy will be continued in all countries

Normal weather and historical ratio of technological innovation are taken for granted

Brazil will maintain anhydrous ethanol blend ratio at 23 %

Baseline Projection

$<10^6 tons>$
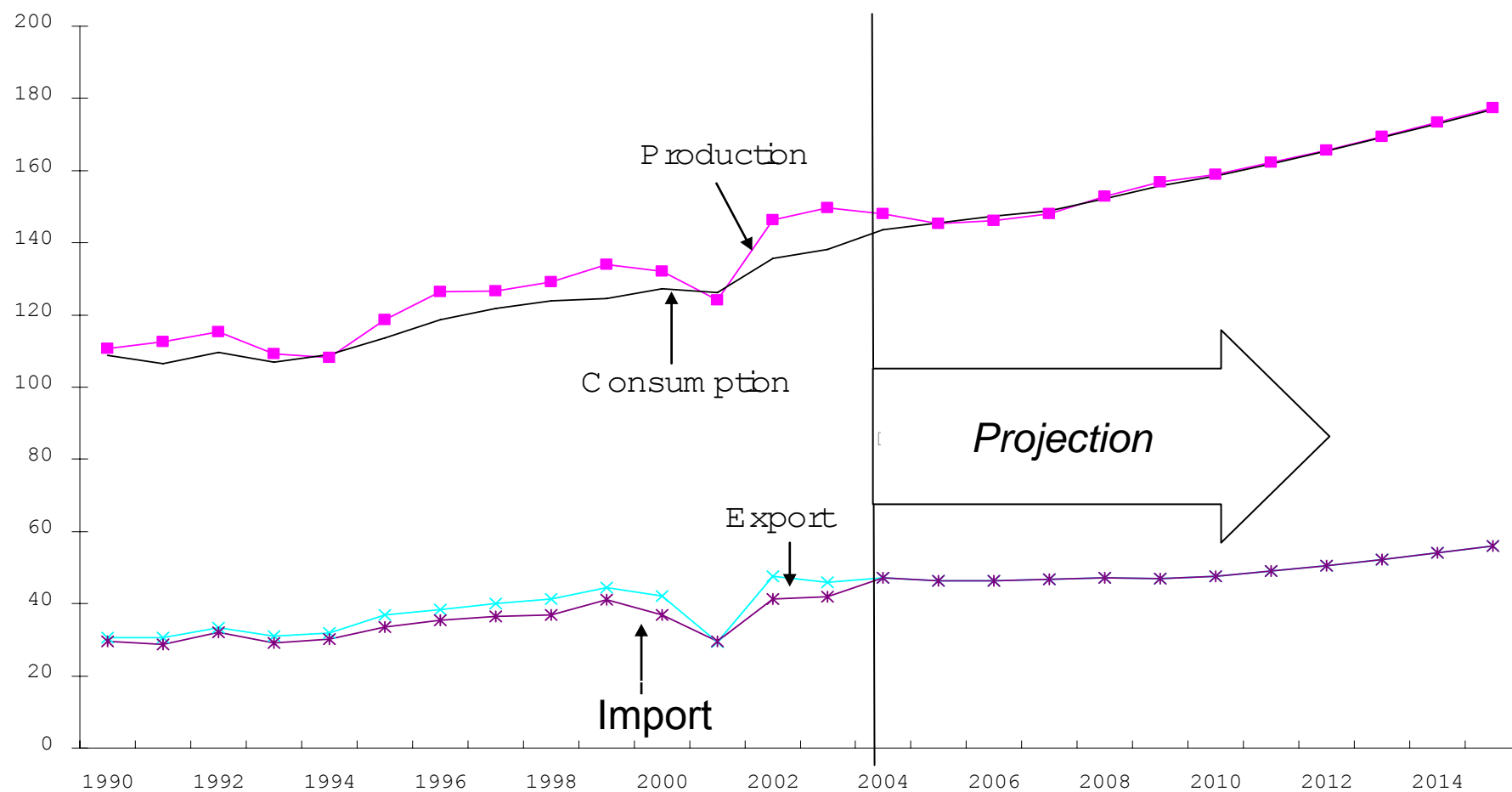
Scenario1

Hypotheses: Japan will start E3 (3 percent bio-ethanol blend in gasoline) program in all areas from 2012 and depend on imported bio-ethanol from Brazil

Bio-ethanol consumption to meet E3 program is predicted to increase at 1,737 thousand kl in 2012 and 1,756 thousand kl in 2015

Japanese gasoline and Bio-ethanol consumption

$<10^3 \text{ kl}>$

	2004	2005	2008	2012	2013	2014	2015
		(Projection)	(Projection)	(Projection)	(Projection)	(Projection)	(Projection)
Gasoline Consumption	61,430	61,064	59,967	59,675	59,894	60,114	60,333
Bio-ethanol Consumption from E3 Program	1,788	1,777	1,745	1,737	1,743	1,749	1,756

Source: Authors' estimate based on Japanese Energy Supply and Use (2006) and International Energy Outlook (2006)

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Imposition scenario2 (Background)

Petrobras plans to export 3 million kl of bio-ethanol not only for fuel-use but also for thermal power generation use from 2010

The use of bio-ethanol use for thermal power generation is at an experimental stage

Setting the blend ratio to heavy oil, modification of thermal power facilities, costs and other technical and transport problems are crucial issues to use bio-ethanol for thermal power
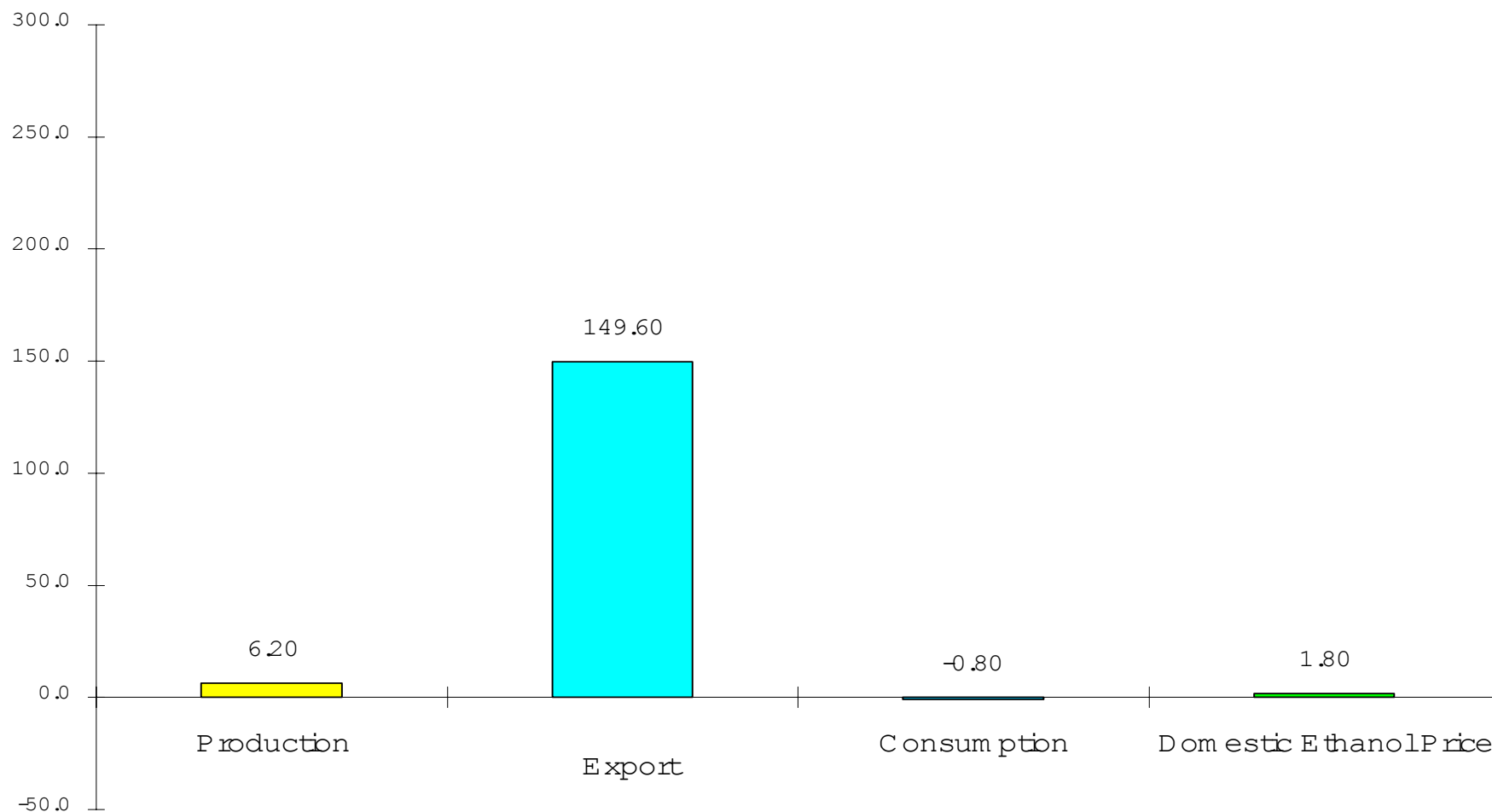
Scenario2

Hypotheses: Japan will import 3 million kl of Brazilian bio-ethanol from 2010, assuming that all the technological and other problems are solved

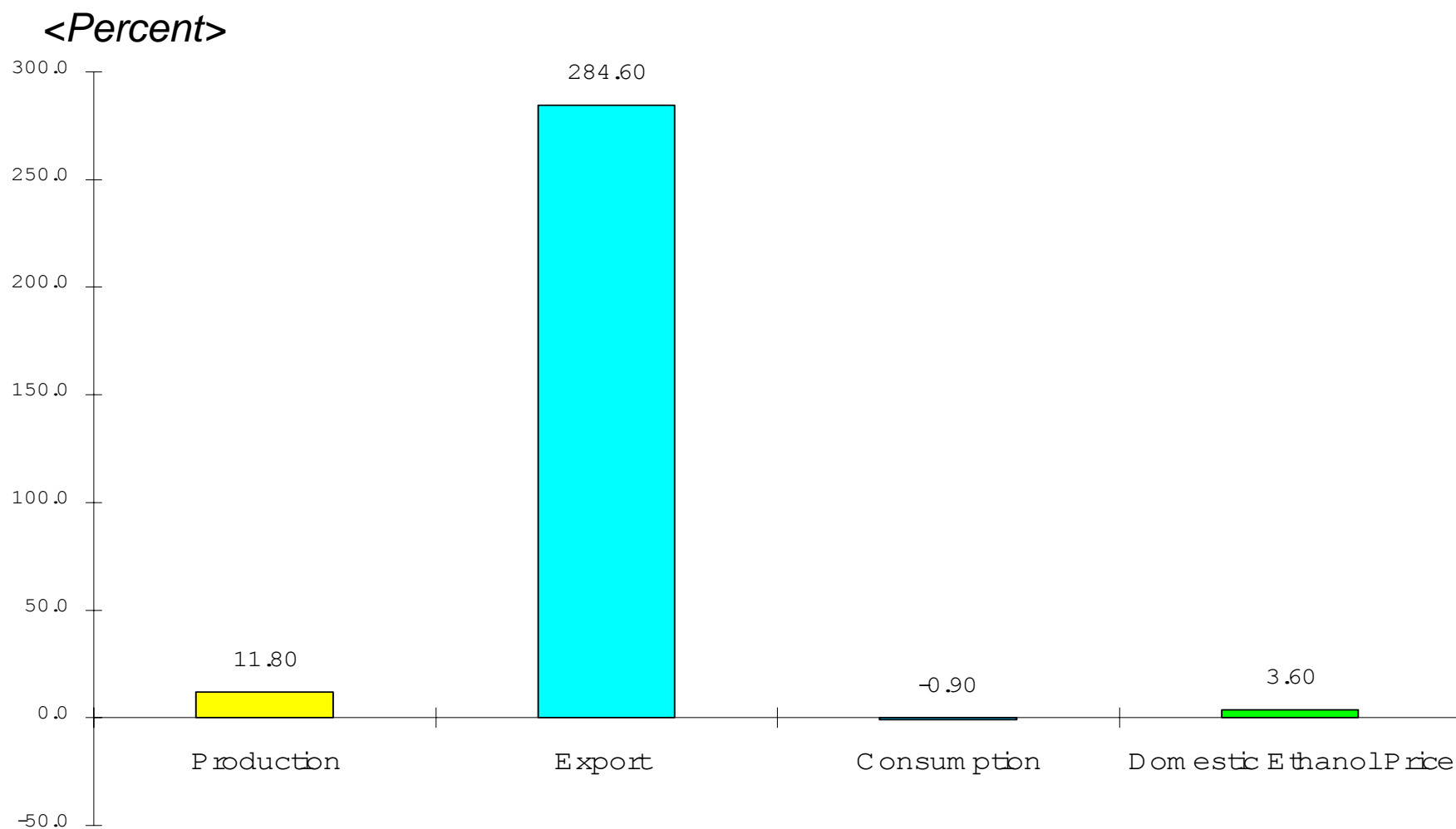Impact on Brazilian Ethanol market (Scenario1/Baseline: 2015)

<Percent>

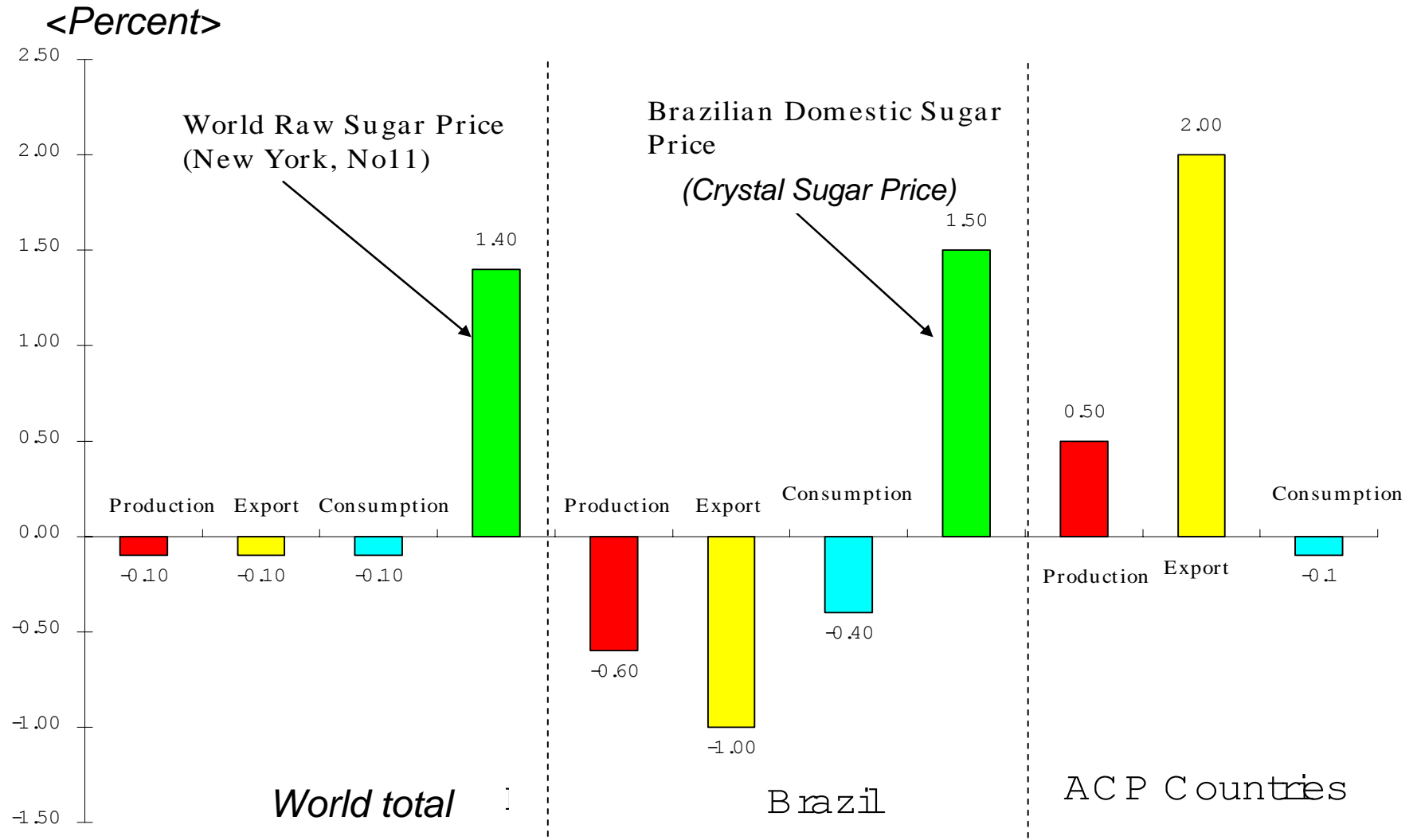Note: Each percentage means "(Scenario1(2015)/Baseline (2015)-1)*100"

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Impact on Brazilian Ethanol market (Scenario2/Baseline: 2015)

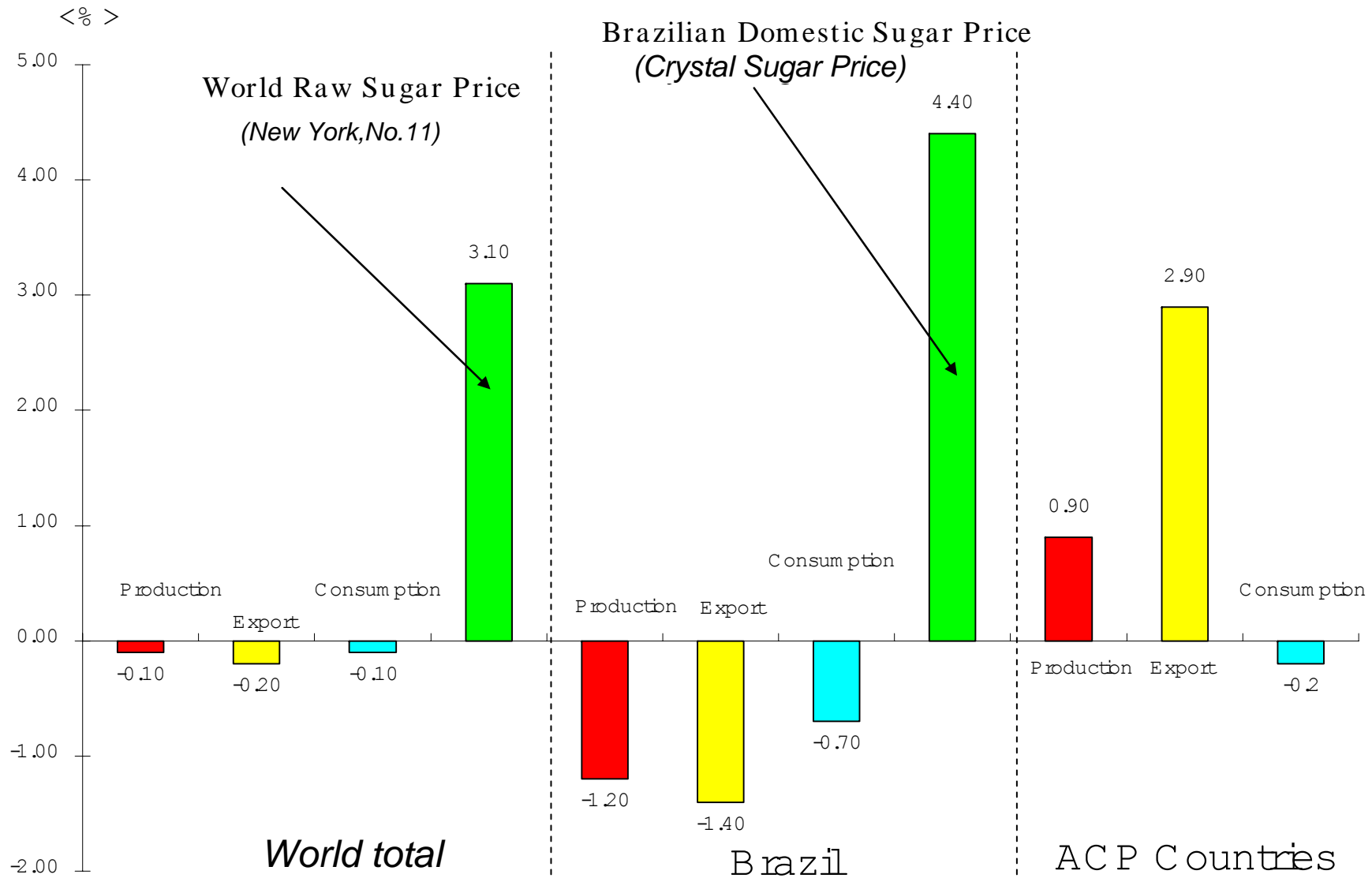Note: Each percentage means "(Scenario2(2015)/Baseline (2015)-1)*100" 44

Impact on Sugar Markets (Scenario1/Baseline:2015)

PRIMAFF

<Percent>

World Raw Sugar Price (New York, No11)

Brazilian Domestic Sugar Price

(Crystal Sugar Price)

World total | Brazil | ACP Countries

Production: -0.10, Export: -0.10, Consumption: -0.10, 1.40

Production: -0.60, Export: -1.00, Consumption: -0.40, 1.50

Production: 0.50, Export: 2.00, Consumption: -0.1

Note: Each percentage means "(Scenario1(2015)/Baseline (2015)-1)*100"

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Impact on Sugar Markets (Scenario2/Baseline:2015)

Note: Each percentage means "(Scenario2(2015)/Baseline (2015)-1)*100"

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Conclusions

The expansion of Japanese bio-ethanol import from Brazil is predicted to impact on not only Brazilian but also world sugar markets

Brazilian bio-ethanol and sugar producers, and some sugar exporters will benefit from relatively higher sugar price

Sugar-importing countries may decrease their import and consumption due to the relatively high sugar price

The expansion of Japanese bio-ethanol import from Brazil can have negative impact on some countries
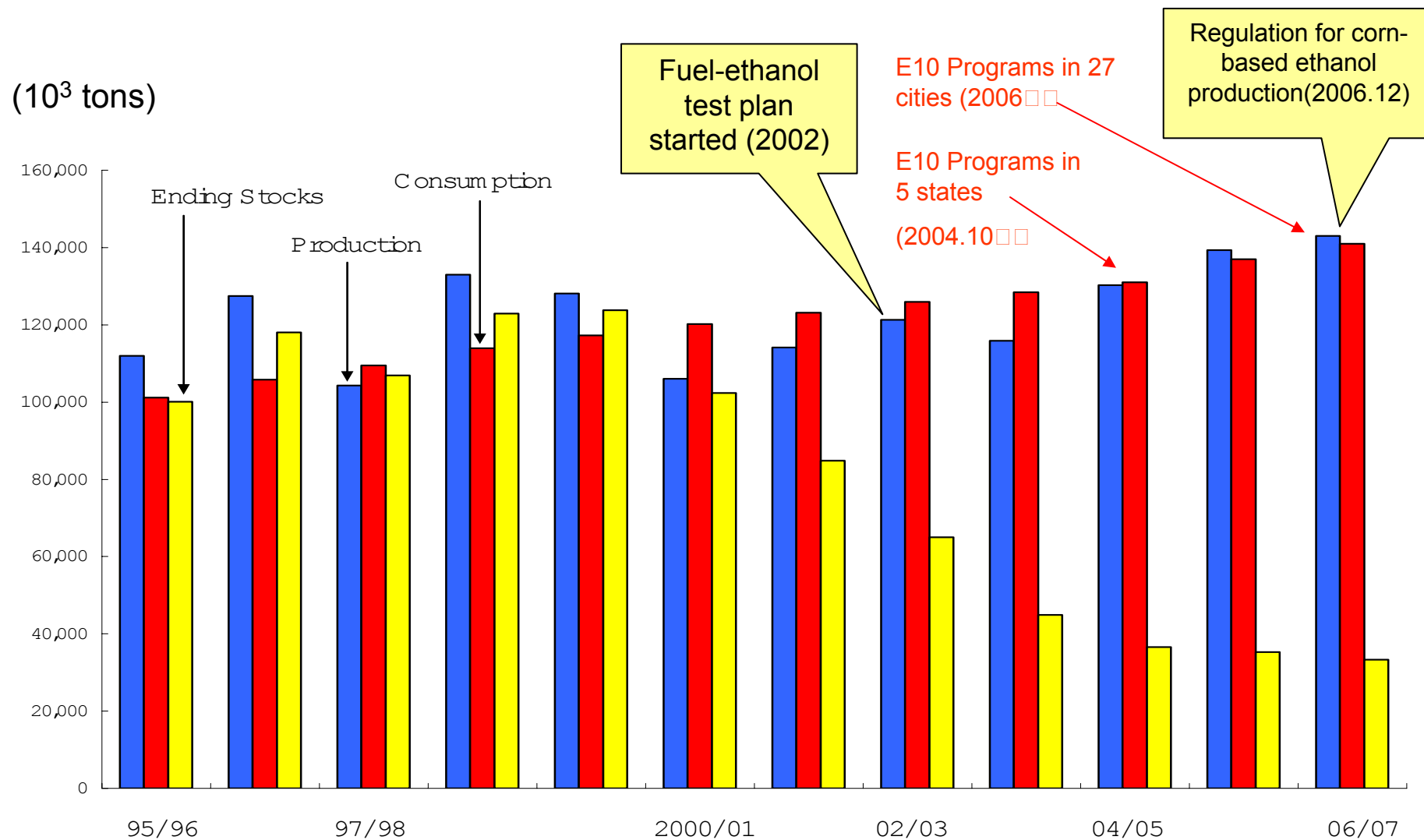
Special thanks to

- Dr. Koji Yanagishima, Economist, Food and Agricultural Organization of the United Nations, Italy

- Dr. Takeshi Sakurai, Senior Economist, Policy Research institute, Ministry of Agriculture, Forestry and Fisheries, Japan

Thank you for your attention !!

Chinese corn production, consumption and ending stocks

(10³ tons)

Ending Stocks

Production

Consumption

Fuel-ethanol test plan started (2002)

E10 Programs in 27 cities (2006

E10 Programs in 5 states (2004.10

Regulation for corn-based ethanol production(2006.12)

Source: FAS, USDA, "PS&D"(2007).

Current and Future Fuel-Ethanol Production (1)

Province	Company Name	Feedstock	2005 production (MT/Year)	2007 production capacity (MT/Year)	Supply location	Supply volume (MT/Year)
Heilongjiang	China Resources Alcohol Co.	Corn	100,000	100,000	Heilongjiang	100,000
Jilin	Jilin Fuel Ethanol Co.	Corn	300,000	600,000	Jilin	100,000
					Liaoning	200,000
Henan	Henan Tian Guan Fuel-Ethanol Co.	Wheat	200,000	200,000	Henan	86,842
					Hubei (9 cities) Hebei (4 cities)	113,158
Anhui	Anhui BBCA Biochemical Co.	Corn	320,000	320,000	Anhui	100,000
					Shandong (7 cities) Jiangsu (5 cities)	220,000
Guangxi	China Resources Alcohol Co.	Cassava	0	110,000	Guangxi	110,000
Hebei	China Resources Alcohol Co.	Sweet potato, corn etc	0	230,000	Hebei	230,000
Hubei	Tian Guan Fuel-Ethanol Co.	Grains	0	100,000	Hubei	100,000
Total			920,000	1,660,000		

Source: Law Concerning Testing of the Extensive Use of Ethanol-Blended Gasoline for Automobiles and Regulations Concerning the Conduct of Testing of the Extensive Use of Ethanol-Blended Gasoline for Automobiles (2006)

Chinese ethanol production cost is higher than other producers
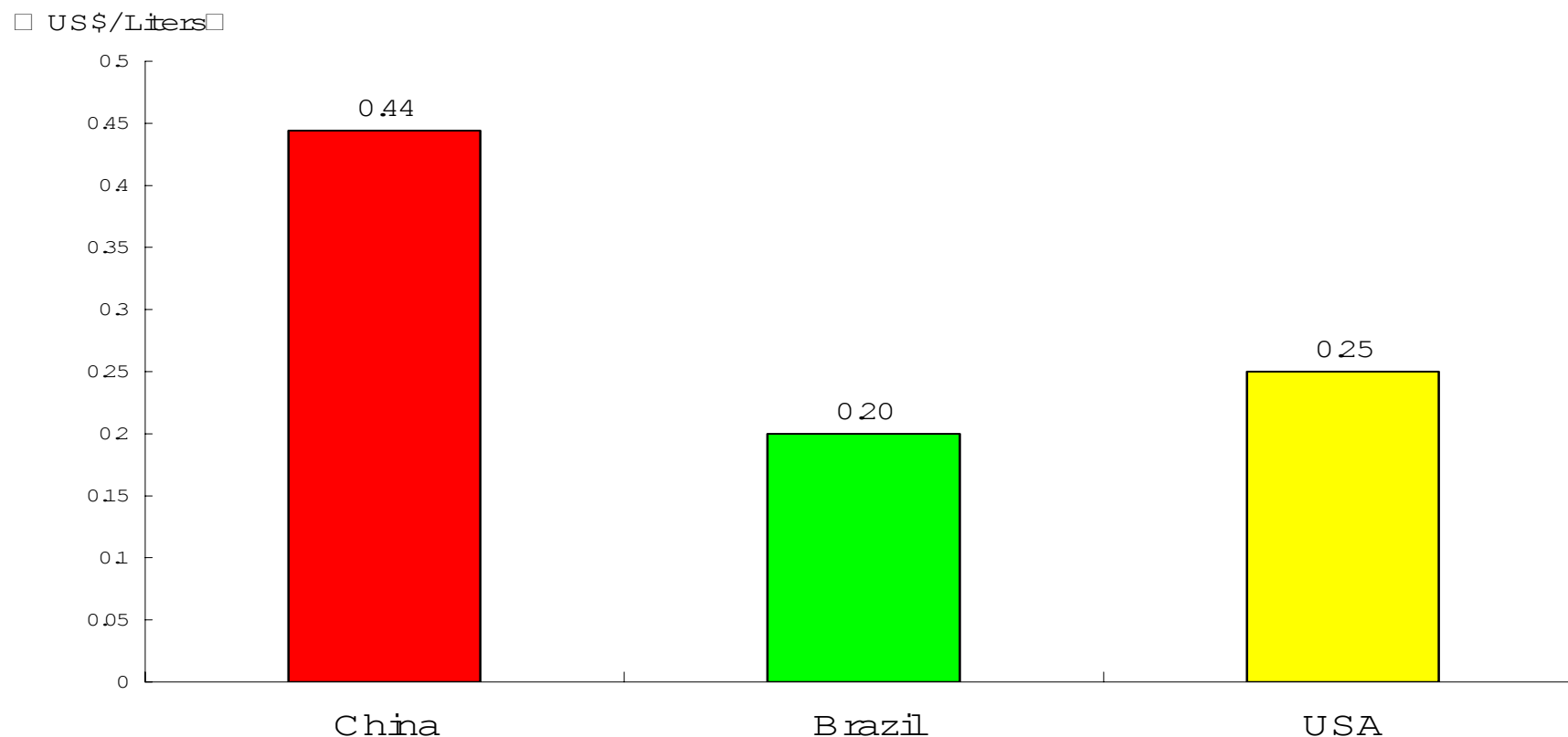
Note: Chinese production cost is derived from the Chinese National Development and Reform Commission.
Brazilian cost is derived from Sao Paulo Sugarcane Agroindustry (2005)
The US cost is derived from USDA (2006)

If China expands ethanol production from cassava, China will have to rely on imported cassava

<MT>

○ Chinese cassava imports

Indonesia

Vietnam

Thailand
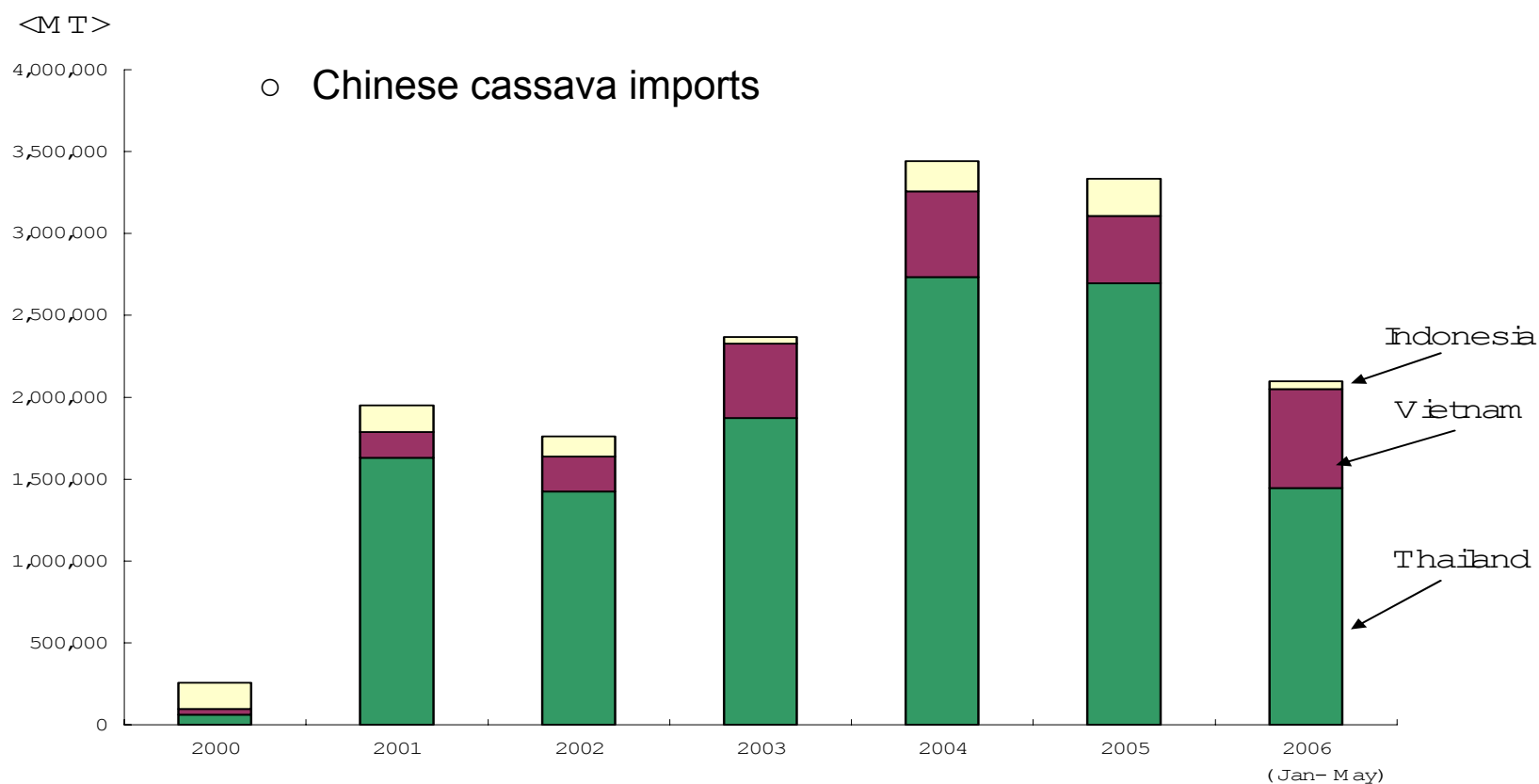
Source: USDA, Grain Report, China, Peoples Republic of Bio-fuels An Alternative Future for Agriculture, CH6049 (2006).

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Conclusions (China)

80% of fuel-ethanol was made from corn in China in 2005

Chinese central government wants to regulate corn-based ethanol production

Chinese government wants to diversify the sources of fuel-ethanol production, especially to cassava

Technological innovation is required for developing cassava-based fuel-ethanol production

2. U.S. Ethanol Programs

Corn is the major feedstock used to produce ethanol.

The U.S. ethanol market was initiated in the 1970s when oil price disruptions impacted on the U.S. economy.

The Clean Air Act Amendments (CAAA90) boosted ethanol markets.

The two methods to increase the oxygen level of gasoline consist in blending it with ethanol or MTBE (methyl tertiary butyl ether).

Most oil refiners choose MTBE because of its economic and blending characteristics.

In March 1999, Governor Gray Davis announced a phase-out of the use of MTBE in California after 2002.

By the end of 2005, 25 States had barred MTBE or passed laws banning its use.

MTBE was replaced by ethanol as an oxygenated fuel.

The ethanol consumption increased by 9.6% per year between 1992 and 2004. (EIA 2005)

The Energy Policy Act of 2005 (EPACT 2005) established the Renewable Fuel Standards (RFS) , which made the use of biofuels mandatory, from 4 billion gallons to 7.5 billion gallons by 2012.

EPACT 2005 doesn't provide MTBE producers with any protection against lawsuits.

Most petroleum companies are trying to move away from MTBE before the 2006 summer driving season.

Some States have their own renewable fuels programs.

California, Minnesota, Montana and Hawaii have passed legislation for ethanol use requirements.

Some other States are following thorough with these ethanol use requirements.

The RFS, MTBE phase-out and ethanol use requirements will lead to expanding ethanol markets.

5 Scenarios

(1) Baseline scenario (assumptions) (1)

The current agricultural policy will be continued in all countries.

Normal weather and historical rates of technological innovation are taken for granted.

MTBE will be eliminated in all States and RFS will be enforced during the projection period.

California, Minnesota, Montana and Hawaii will proceed and start their own ethanol use requirements.

(1) Baseline scenario ( )

The U.S. ethanol use requirements are projected to increase from 8,221 thousand MT in 2006/07 to 9,188 thousand MT in 2014/15.

|	Unit	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Ethanol use requirement (Corn equivalent): (1)*2.523	1,000	8,221	8,745	8,810	8,871	8,929	8,984	9,041	9,095	9,144	9,188
Ethanol use requirement : (2)=(3)+(4)+(5)	1,000KL	3,259	3,466	3,492	3,517	3,540	3,561	3,584	3,605	3,625	3,642
Ethanol use requirement in California (3)	1,000KL	3,060	3,083	3,105	3,126	3,146	3,164	3,182	3,199	3,214	3,227
Ethanol use requirement in Montana (4)	1,000KL	199	200	202	203	204	205	207	209	210	212
Ethanol use requirement in Hawaii (5)	1,000KL	–	183	185	188	190	193	195	198	200	203

(Source) Authors' estimate based on State Energy Outlook (2006) and Annual Energy
Outlook 2006.
(Notes) Ethanol consumption in Minnesota is projected to exceed their ethanol use requirements.

Fuel-ethanol consumption (Baseline projections)

<10^3 tons>
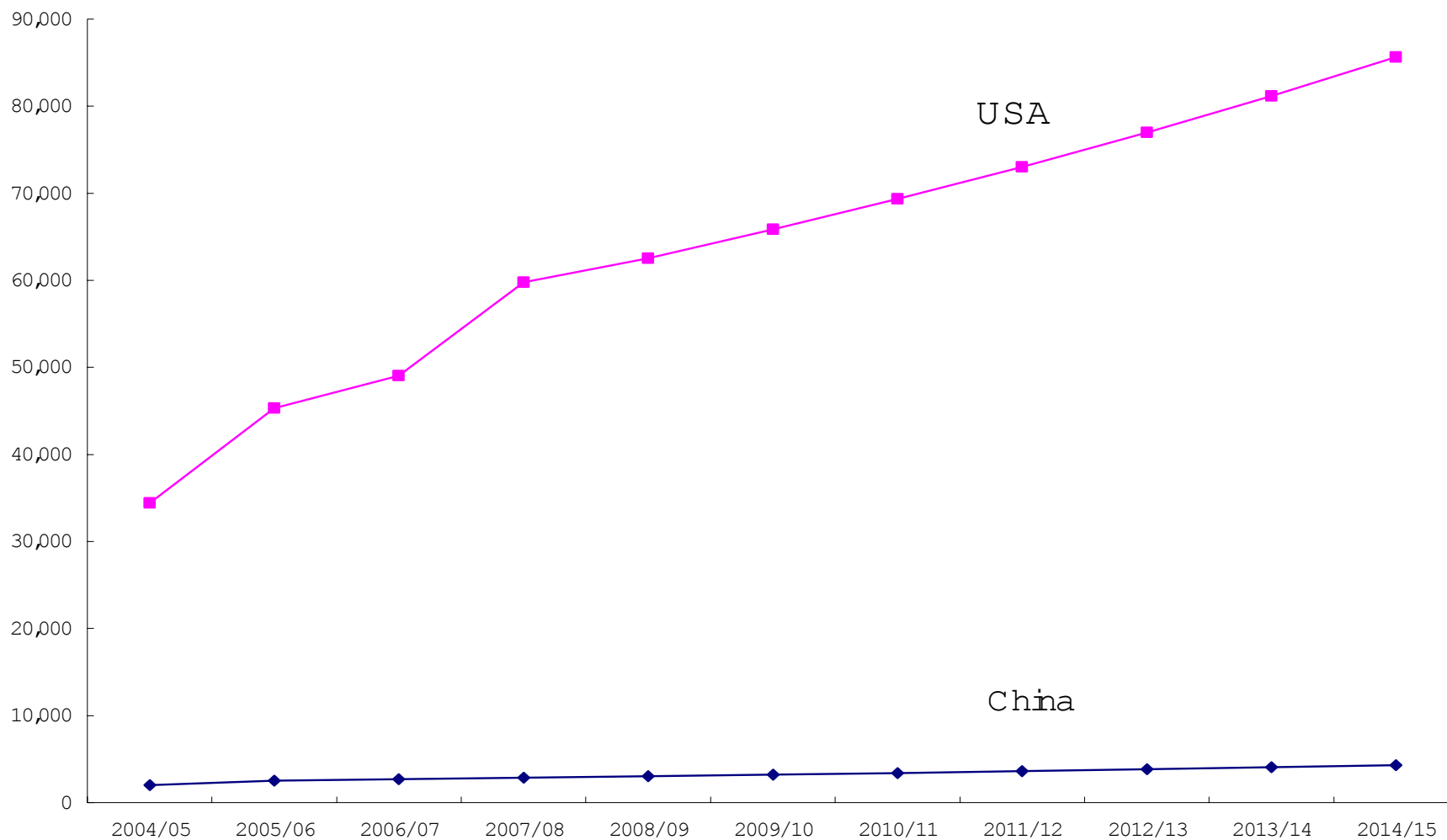
Studies for U.S. and Chinese ethanol policies and markets.
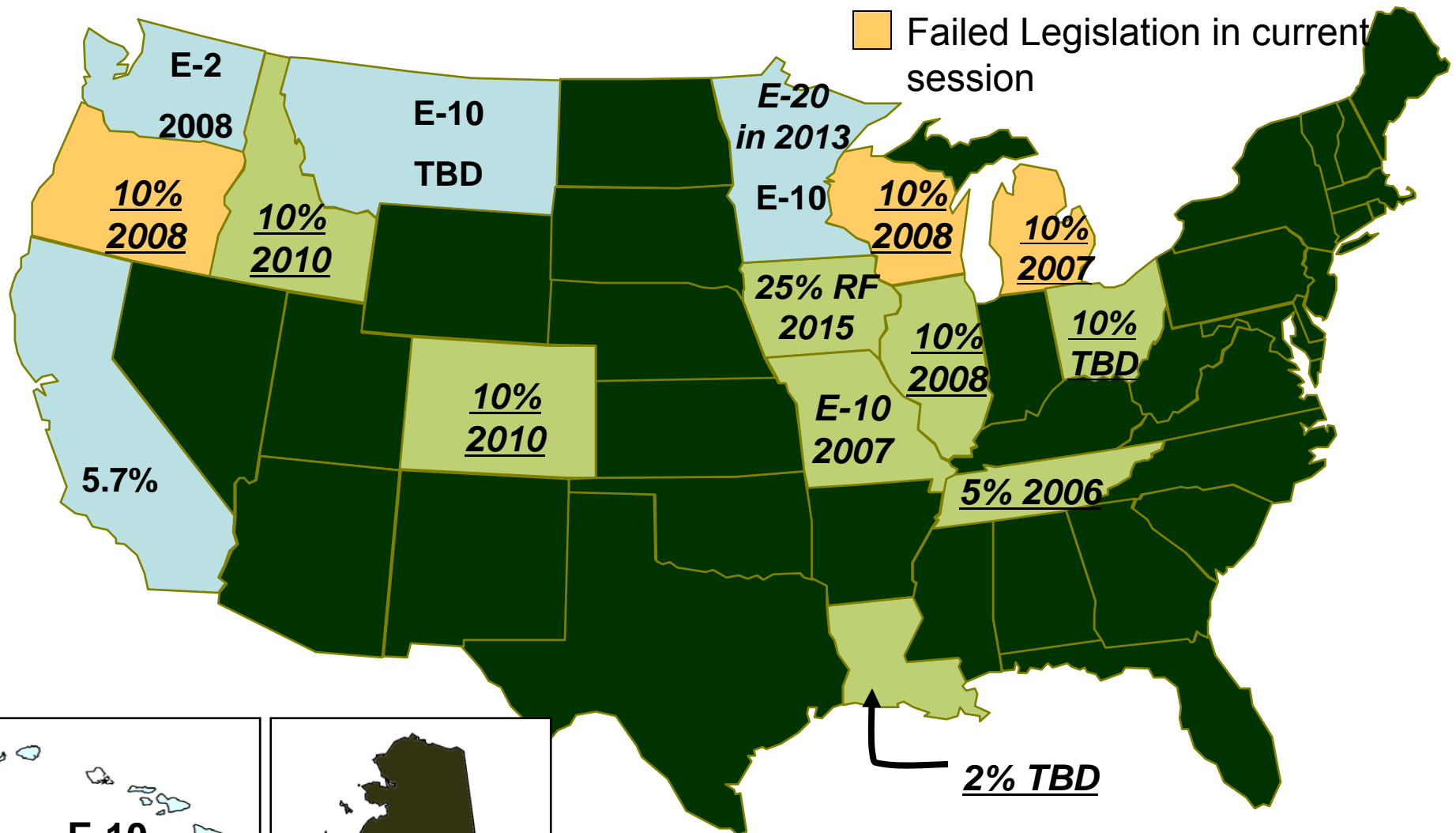
The increased ethanol production will raise the corn price and benefit to corn producers. (US General Accounting Office 1990)

MTBE phase-out will increase the amount of ethanol production from corn and impact on domestic crops and feed prices. (Ferris 2004, USDA 2002)

Chinese ethanol will impact on domestic and international corn markets. (Koizumi and Ohga 2006)

Neither of these studies dealt with how the concurrent U.S. and Chinese fuel-ethanol programs would impact on the world corn market.
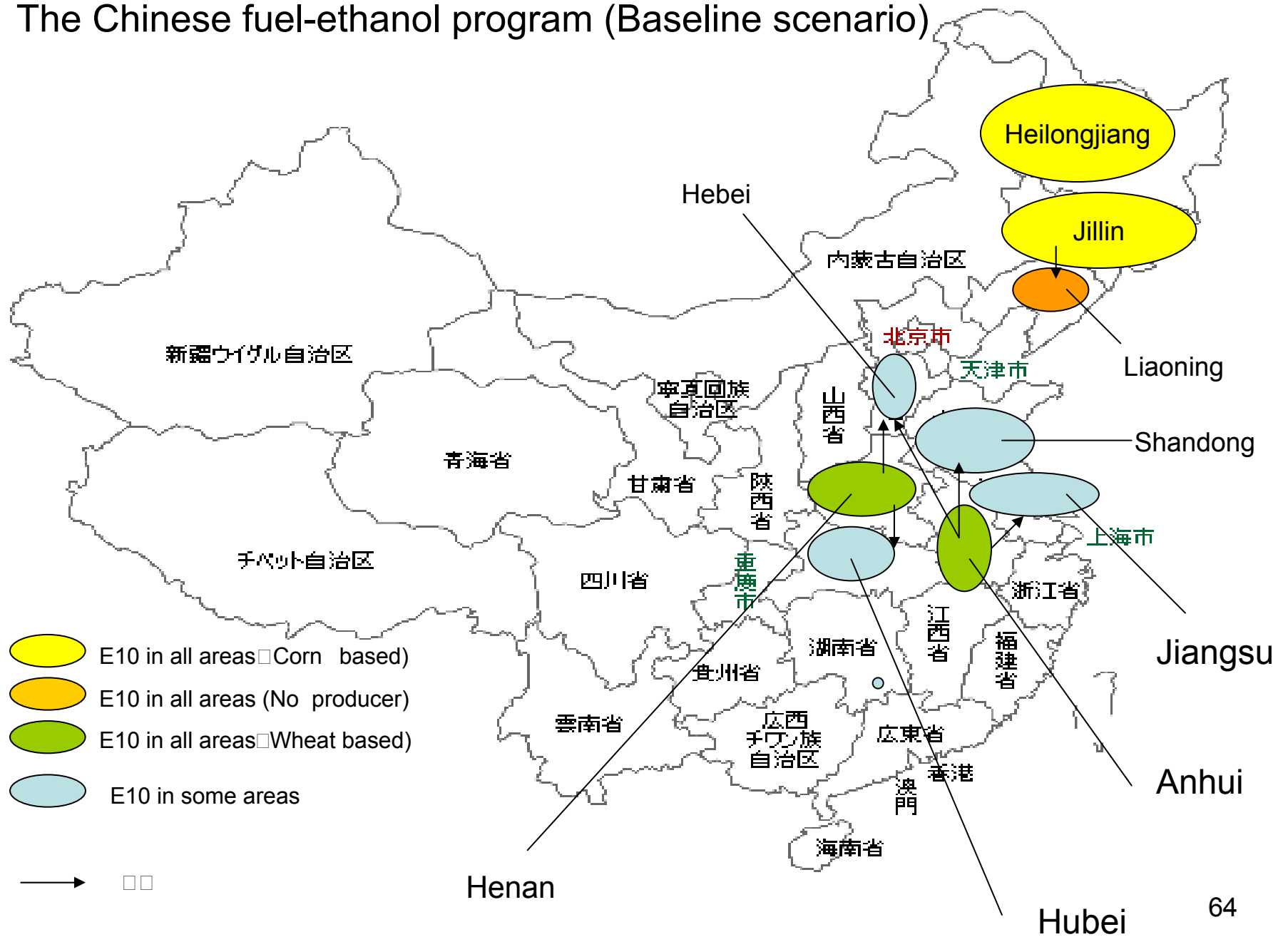
Ethanol Use Requirements

Law enacted   Pending Legislation

Failed Legislation in current session

E-2

2008

E-10
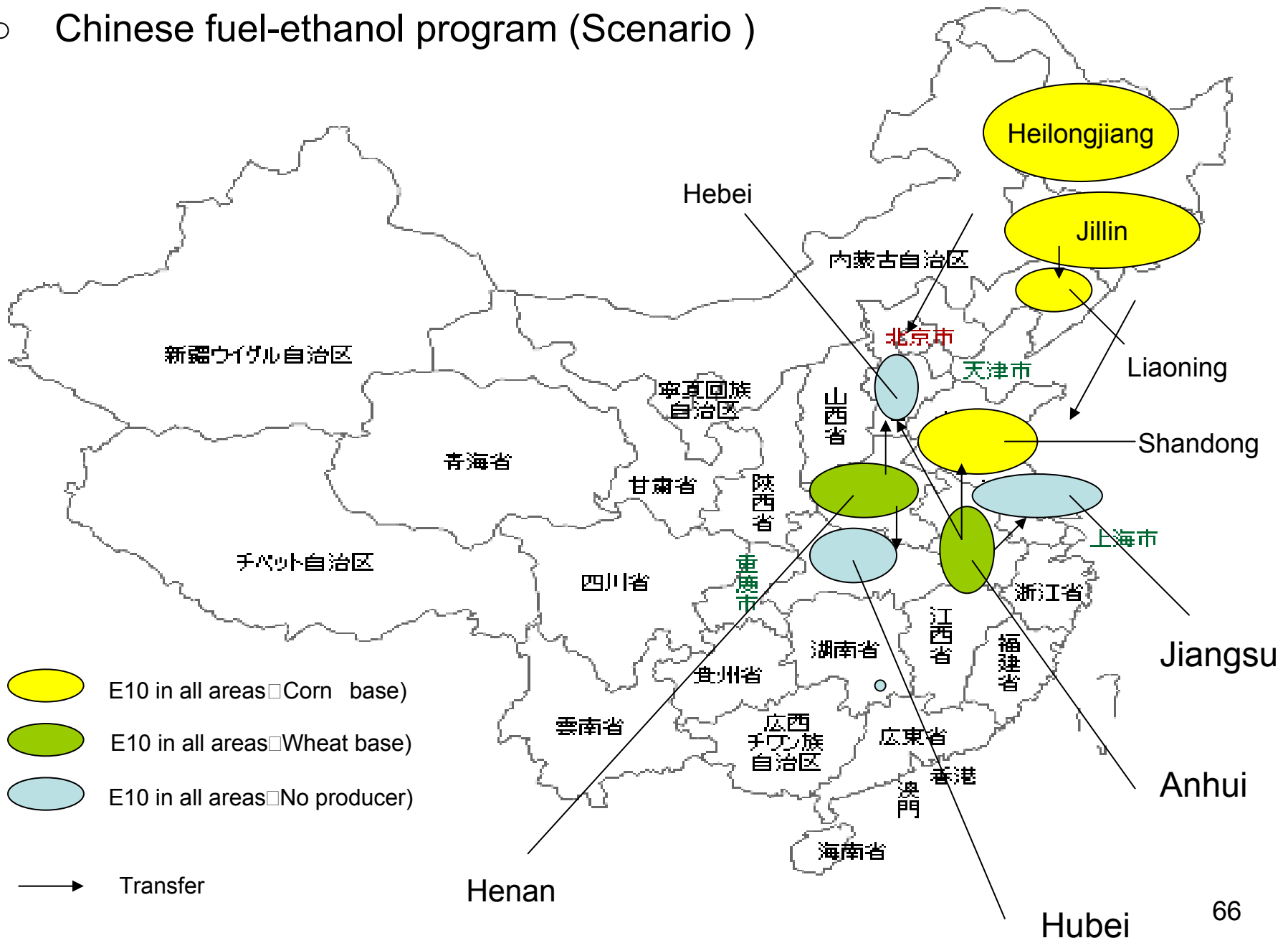
TBD

E-20 in 2013

E-10

10% 2008

10% 2010

10% 2008

10% 2007

25% RF 2015

10% 2008

10% TBD

5.7%

10% 2010

E-10 2007

5% 2006

2% TBD

E-10

2006

63

(Source) NCGA (May 2006)

○ The Chinese fuel-ethanol program (Baseline scenario)

E10 in all areas（Corn based)

E10 in all areas (No producer)

E10 in all areas（Wheat based)
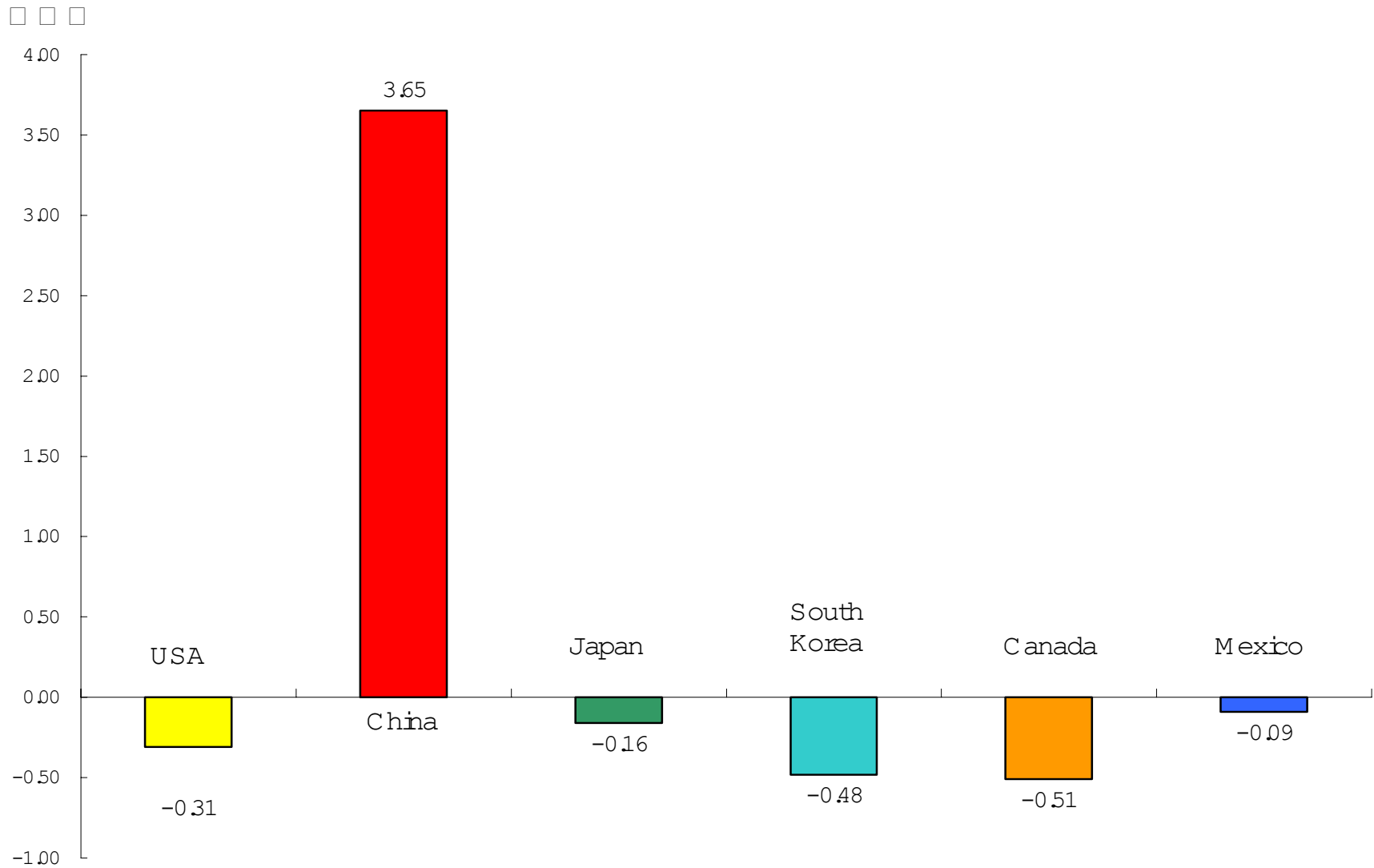
E10 in some areas

64

< Wheat based ethanol >

  The Chinese government will maintain and promote the E10 program in Henan and Anhui from 2006.

 Henan and Anhui are assumed to meet ethanol consumption in Shandong, Jiangsu, Hebei and Hubei.

○ Chinese fuel-ethanol program (Scenario)

Heilongjiang

Jillin

Hebei

内蒙古自治区

新疆ウイグル自治区

北京市

天津市

Liaoning

寧夏回族
自治区

青海省

甘粛省

山西省

陝西省

Shandong

Jiangsu

チベット自治区

四川省

重慶市

上海市

浙江省

湖南省

江西省

福建省

雲南省

貴州省

広西
チワン族
自治区

広東省

香港

Anhui

海南省

澳門

E10 in all areas Corn base)

E10 in all areas Wheat base)

E10 in all areas No producer)

Transfer

Henan

Hubei

66

○ Impacts on World Corn Consumption Scenario / Baseline)
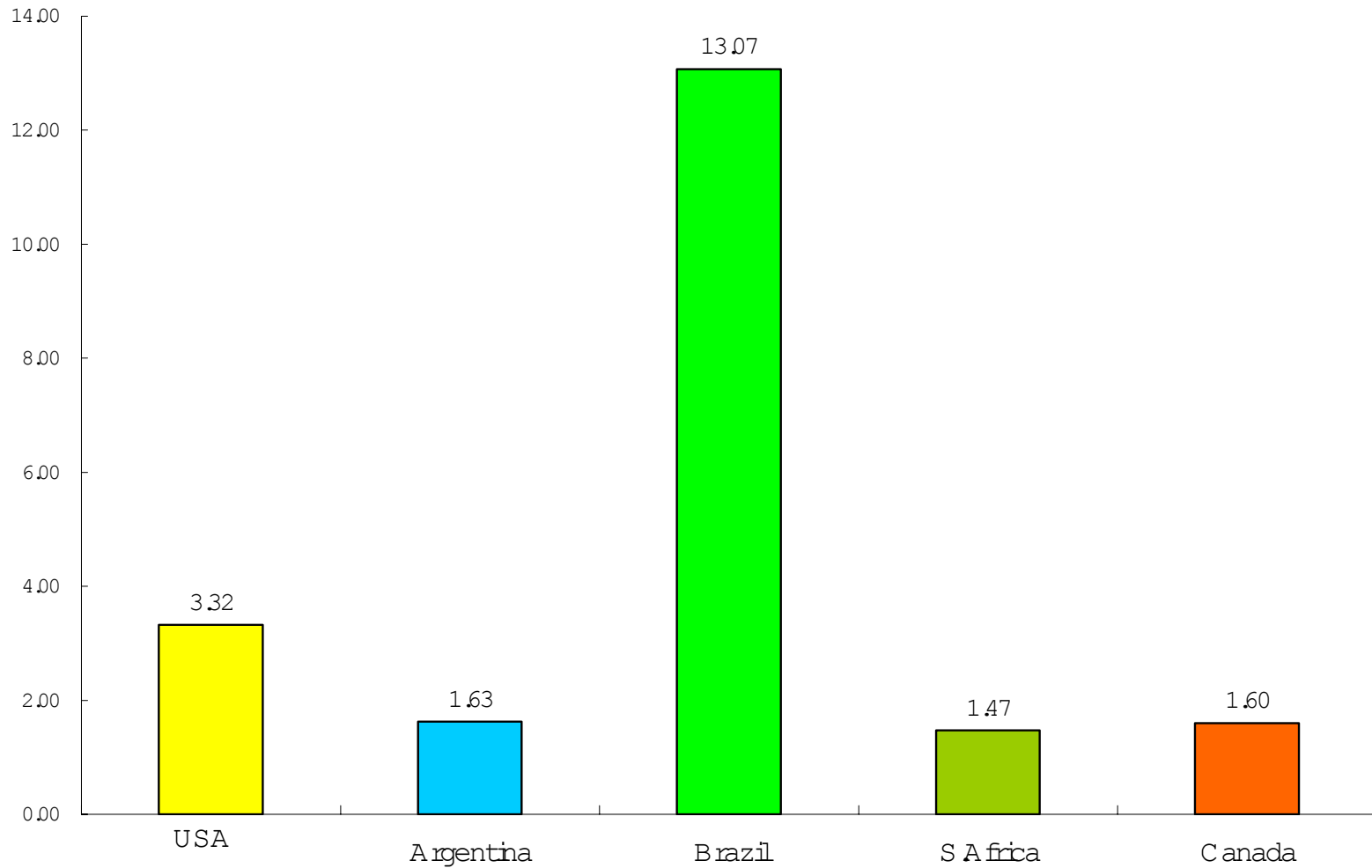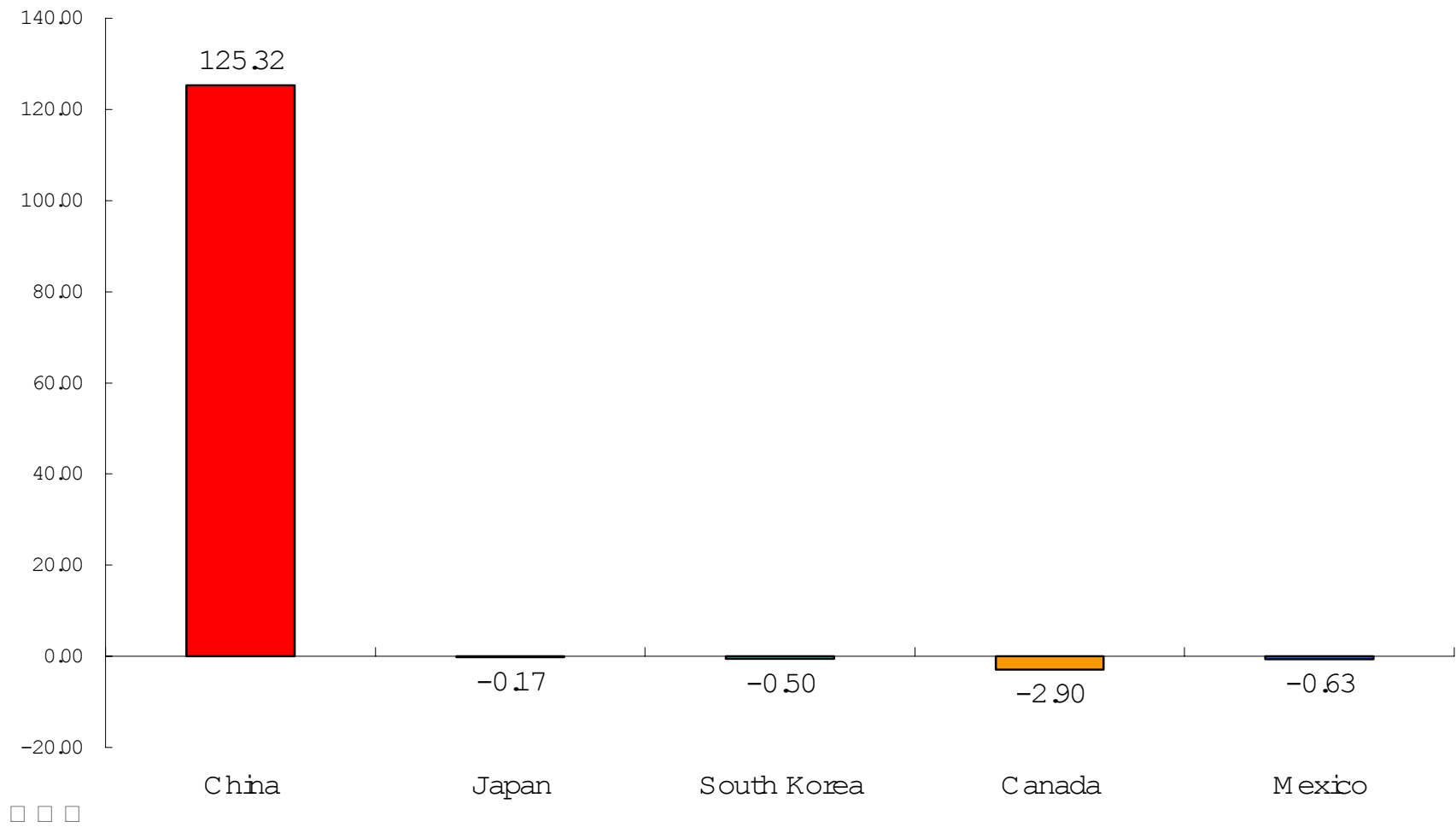
○ Impacts on World Corn Production Scenario / Baseline)
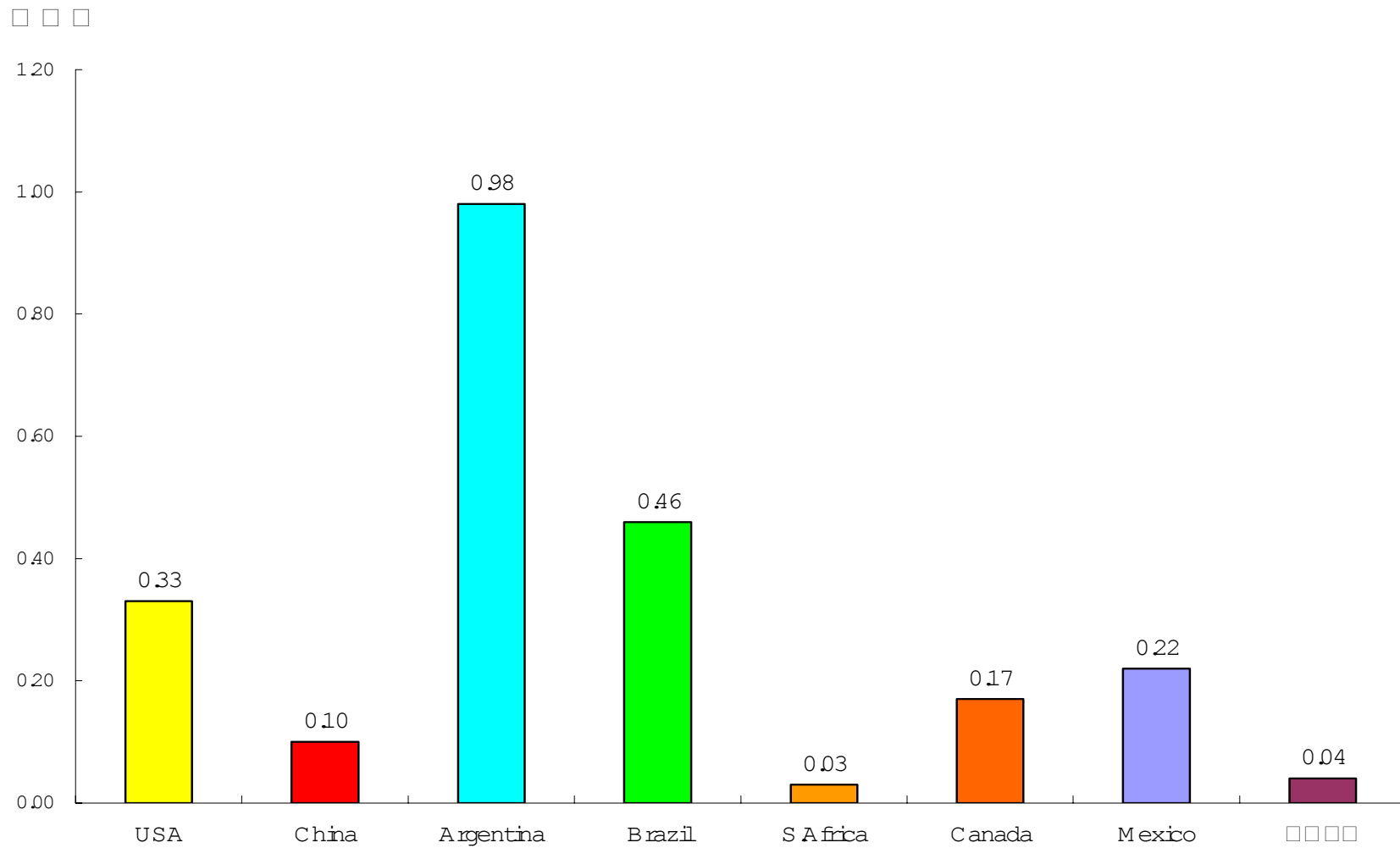
○ Impacts on World Corn Exports Scenario / Baseline)

○ Impacts on World Corn Imports（Scenario / Baseline ）

For Further Promotion of Domestic Bio-Ethanol (Japan)

The abandoned arable land can be used to grow crops for bio-ethanol production

Farmland planted with crops may be used to provide raw materials for bio-ethanol

Technological innovation is the key

Conclusions (Japan)

Japanese government promotes bio-ethanol production and utilization for automobile

Securing feedstock for bio-ethanol, reduction of production cost, tax reduction for bio-ethanol are needed to expand bio-ethanol production in Japan

Further technical innovation is the key factor to promote domestic bio-ethanol production