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MEXICO

SELECTED ISSUES

November 2014

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MEXICO

SELECTED ISSUES

October 23, 2014

Approved By
Western Hemisphere Department

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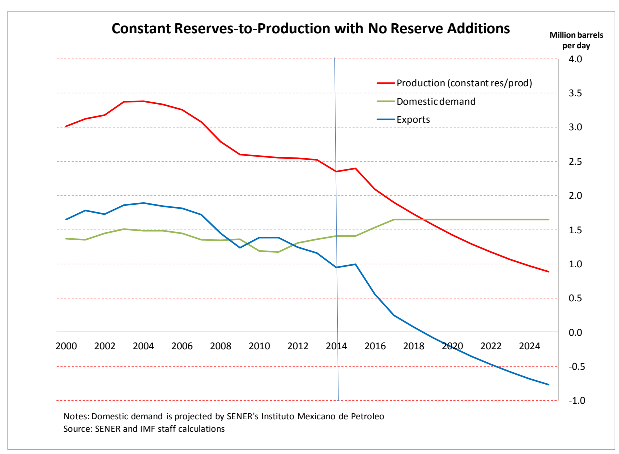
THE IMPACT OF MEXICO'S ENERGY REFORM ON HYDROCARBONS PRODUCTION[1]

1. The recently adopted energy reform could revolutionize Mexico's hydrocarbons sector. The reform aims to increase oil and gas production by eliminating the state oil company's (PEMEX) monopoly on exploration and production of hydrocarbons, while retaining the prime directive that these resources are the property of the Mexican nation. Additionally, competition and new regulatory structures are being implemented in midstream and downstream activities to enhance the generation and distribution of natural gas and electricity to increase the efficiency of service and reduce costs. Reducing electricity costs, in particular, could have a significant impact on raising manufacturing output as discussed in a companion selected issues paper (SIP).[2]

2. This SIP will discuss the nature of these reforms and what problems these reforms are addressing. It will then present illustrative production scenarios for crude oil and natural gas and estimate the commensurate investment costs and foreign direct investment (FDI) associated with each scenario. The paper also examines the markets for the distribution of natural gas and electricity. It concludes with the key messages from our analysis.

A. Current Challenges in the Energy Industry[3]

3. Mexico has been experiencing falling crude oil and natural gas production, bottlenecks in natural gas delivery, high costs of natural gas and electricity, as well as a inefficient energy services.



- Crude oil production has fallen to 2.5 million barrels per day (mmbd) since its peak in 2004 of 3.4 mmbd, as the country's giant fields mature. Despite significant probable and prospective reserves and increasing capital expenditures by PEMEX, the country has only about a decade's worth of proven crude oil

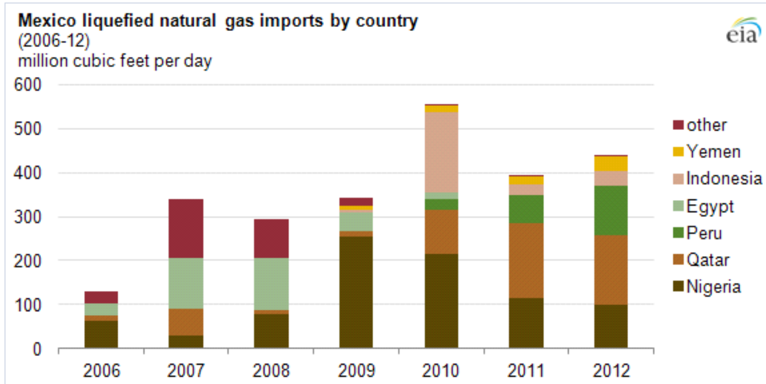
[1] Prepared by Phil de Imus.

[2] See Selected Issues Paper Made in Mexico: the Energy Reform and Manufacturing Output.

[3] The scope of Mexico's energy reform is wider than what is covered in this SIP. There are important reforms that are aimed at improving oil refining and distribution, liberalizing gasoline prices, and addressing some of the environmental concerns.

reserves. PEMEX has had a difficult time fully replacing these reserves each year, achieving this only twice in recent years. The yield from new fields has on the whole disappointed expectations, and old fields are in their depletion phase. Without significant additions to proven reserves and if the reserves-to-production ratio is held constant at the average of the last 5 years, production would fall to about 1.5 mmbd and Mexico would turn into a net oil importer[4] before the end of the decade (see chart).

- Natural gas production has also fallen to 6.4 billion cubic feet per day (bcfd) from a peak of 7.0 bcfd in 2010. Mexico has been a natural gas importer since 2002, and imports have been growing significantly since 2009. The country mostly imports natural gas via pipeline from the US, but growing demand has forced it to rely at the margin on much higher priced liquefied natural gas (LNG) primarily from Qatar, Peru, and Nigeria (see chart). Domestically, there have been problems with natural gas delivery, with the system experiencing a significant number of critical shortages that had a negative impact on industrial production in 2013.



Source: U.S. Energy Information Agency and International Energy Agency

- Mexican consumers pay a significantly higher price for electricity than its northern neighbors and the efficiency of service is weaker than many other OECD countries (see companion SIP for further discussion). The electricity sector has had earlier reforms, which allowed some competition to the Federal Electricity Commission (CFE), the state-owned electric utility. Private actors were allowed to produce power, independent power producers (IPPs), who had to sell their power to CFE before it sold on to third parties, and large electricity consumers who could self-generate. The latter though had limited ability to sell any excess generation to the market. Moreover, while much of the new generating capacity has been natural-gas based, higher priced diesel and fuel oil generation is still used at the margin to meet this demand. Finally, the transmission and distribution system is relatively old, receives little investment, and experiences relatively high losses, which raises the cost of delivery and reduces reliability.

B. Most Significant Reform Effort in 75 Years

4. Congress approved several constitutional amendments in December 2013, and passed all the secondary legislation in August 2014. The principles of the reforms were the reaffirmation

[4] Assuming oil demand rising in line with the scenario prepared by the Ministry of Energy (SENER).

that the nation owned the hydrocarbons in the ground; promotion of open and competitive markets between state enterprises and private firms in both upstream, midstream, and downstream operations; strengthening of the regulatory framework and institutions and the transformation of Pemex and CFE; transparency and accountability of transactions; industrial safety; and the protection of the environment and promotion of clear energy.[5]

5. These principles are carried out in practice by:

- **Opening up markets to competition**. In mid-2014, the government completed the first round of allocating Mexico's oil fields (so-called "Round 0"), which assigned over 80 percent of Mexico's proven and probable oil reserves to PEMEX. In 2015, the government will begin to auction the remaining exploration and production (E&P) blocks to state-owned and private firms. The state will enter into a range of risk-sharing contracts with the winning bidders, which include profit- and production-sharing as well as licenses. The flexibility in contracts makes it likely that foreign firms will be willing to undertake the risk of exploration, while at the same time providing incentives to ensure the state gets an appropriate share. The electric generation market will be further opened up to allow independent power producers and firms that generate their own electricity to sell directly to the market. Starting in 2018, domestic gasoline prices will become fully market-determined, and PEMEX's monoposony on gasoline imports will disappear.

- **Transformation of Pemex and CFE**. Both state enterprises have been changed to state productive enterprises, with greater autonomy in operations and budgeting. Gradually over time, the fiscal take from PEMEX will be lowered to 65 percent as new fiscal regimes take hold over the next 5 years. PEMEX will be allowed to enter into joint ventures and other contracts to develop fields it received in Round 0. CFE will be allowed to contract with private parties for natural gas supply and for investment and operations of transmission and distribution projects.

- **Strengthening of the regulatory framework**. The role of the Ministry of Energy (SENER) and the National Hydrocarbons Commission (CNH) are enhanced, so that new E&P contracts will be agreed with the federal government and not PEMEX. Transparent auctions will be conducted by CNH, and it will manage the contracts. Independent system operators, National Center for Energy Control (CENACE) and National Center for Control of Natural Gas (CENEGAS), are created to improve the efficiency of natural gas and electricity distribution and reduce potential conflicts of interest. The Energy Regulatory Commission (CRE) will set tariffs for transmission, distribution, and ancillary services.

- **A domestic content rule**. Both assignments to PEMEX and other contracts will have domestic content rules that gradually rise to 35 percent by 2025. There is also a minimum participation

[5] The focus of this SIP is on the former four principles. It does not examine issues of environmental protection and industrial safety. Important reforms were enacted here, including the creation of a new regulatory agency.

rule of 20 percent for PEMEX in deep water trans-boundary projects in order for it to gain the know-how in that arena.

- **A new, independent sovereign wealth fund**. The Mexican Oil Stabilization Fund, managed by the central bank, has been created to administer the proceeds and payments from assignments and contracts. This aims to increase transparency and could allow the government to save more of its oil revenues.

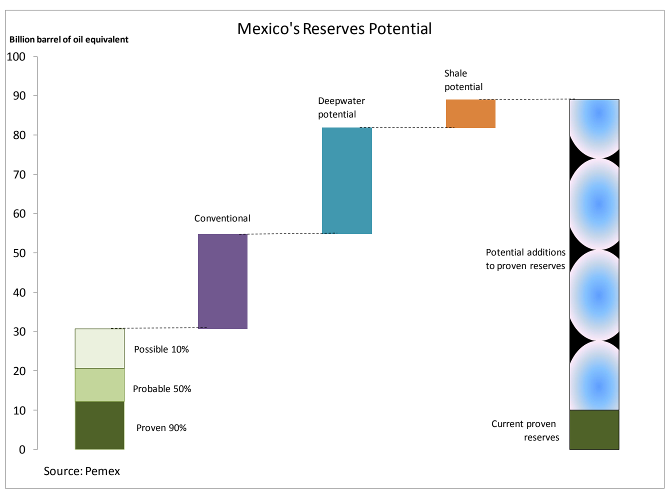
C. Impact on Energy Production

6. We present baseline and downside scenarios for crude oil and natural gas production for illustrative purposes only. The assumptions used were culled from discussions with and documents from the relevant Mexican authorities, academics, and analysts from the private sector.

7. We approach the analysis by asking the following questions. Are there enough potential reserves given the current geological estimates? What is the timeline for production given the type of production, i.e. conventional, enhanced recovery, deepwater or shale? What would particular targets for production imply for the proven reserve replacement ratios (RRRs) [1]over time, and how do those RRRs compare to historical trends. Additionally, how much would it cost to attain these RRRs, and given assumptions for the domestic content rules, how much FDI could the projects attract?

D. Resource Blessed

8. According to PEMEX's statistics, crude oil and natural gas reserves are substantial. Proven reserves, which are estimated to be extractable with at least 90 percent probability, amount to 10 billion barrels (bbl) of crude oil and 13.6 trillion cubic feet (tcf) of natural gas. Possible and probable reserves, those estimated to be extractable with a probability of 50 to 90 percent and 10 to 50 percent respectively, are reported to be 21 bbl and 38.5 tcf (see chart). These resources represent those in the current fields that have been explored and are being produced by Pemex as of end-2013.



[1] The proven RRR is a key statistic which indicates how much of the production in a year is replaced by additions to proven reserves. For example, a 100 percent RRR means that given 1 barrel in production, the energy company is able to find 1 new barrel of oil in proven reserves. This would keep the level of proven reserves at a constant level.

9. Deepwater and shale could yield sizeable new reserves, but more exploratory drilling is required to more accurately measure the amounts. According to PEMEX, there is an estimated 27.1 billion barrels of oil equivalent (bboe) in the deep water Gulf of Mexico (GoM) and 60.2 bboe in shale deposits in the northern part of the country. The U.S. Energy Information Agency ranks Mexico 8th among countries with 13 bbl of technically recoverable shale oil resources and 6th with 545 tcf of technically recoverable natural gas. However, the number of exploratory wells in deepwater and shale are relatively small compared to those in the U.S. side of the GoM, the deepwaters of Brazil, and the shale fields in Eagle Ford Texas, so more information is need to ascertain the amounts.

E. How Long Does it Take?

10. The process of passing the constitutional reform and secondary laws are now complete, as well the Round 0 assignment of fields to PEMEX. The immediate next step is to implement Round 1 of bidding for the fields that were not assigned to Pemex. It is crucial that the process in this round goes relatively smoothly and is perceived to be transparent to maintain investor and political confidence in the reform. The bidding process is expected to be completed by the second half of next year. Additionally, important regulatory changes are taking place that cover exploration and production, as well as the distribution of both natural gas and electricity.

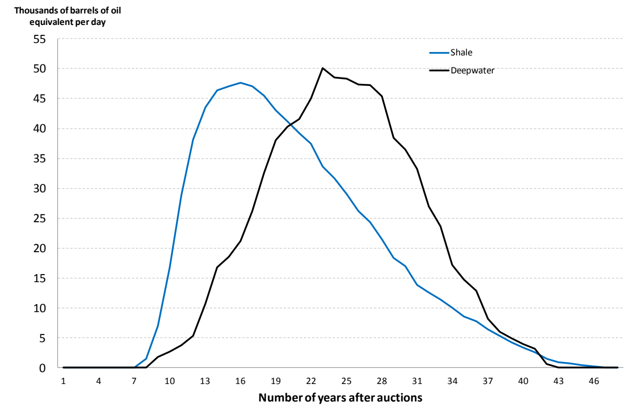
11. Over the next few years, improvements to production are more likely to come from developing conventional fields, and secondary and enhanced recovery from existing, producing fields. The government will likely have to rely on these sources from both PEMEX and new entrants to meet its goal of increasing crude oil production to 3.0 mmbd by 2019.[1] These projects will take less time than unconventional sources given relatively faster processes, less complexity, and PEMEX's enhanced ability to contract with private firms, including farmouts,[2] to share investment costs or to import advanced technologies. Authorities indicated that about 70 percent of the blocks in the Round 1 auction will be those that are already probable reserves (2P) that are more ready to become proven reserves and for extraction.

[1] The government's 3.0 mmbd production expectations had to be changed to 2019 due to an unexpected decline in Pemex's production in 2013.

[2] Farmouts are E&P projects in which PEMEX contracts with a third party to perform all or parts of a project in blocks assigned to PEMEX in Round 0.

12. While there has been significant attention paid to the shale and deep water potential of the country, they take a long time to develop. They are not likely to yield significant production until the next decade. Goldman Sachs uses data on the experience of deepwater projects in the U.S. side of the GoM and shale projects in the U.S. and Argentina to estimate typical production and cost curves. These estimates suggest that exploration could take place between 2016 and 2018, followed by a decision to commercially develop a discovery 1 to 2 years later. Small amount of production tend to occur between 5 to 10 years after contracts are won, and robust production after that (see chart).

Typical Deepwater and Shale Production Curves



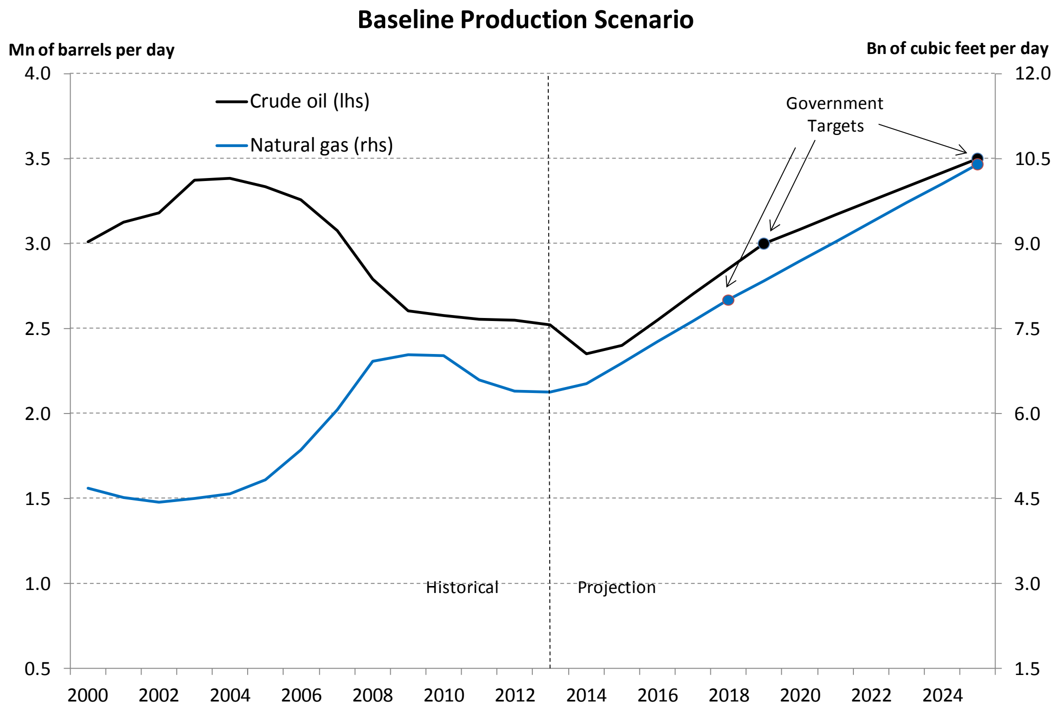
Note: Assumes 300 millon barrels total production over entire period
Source: Goldman Sachs

F. Production Scenarios

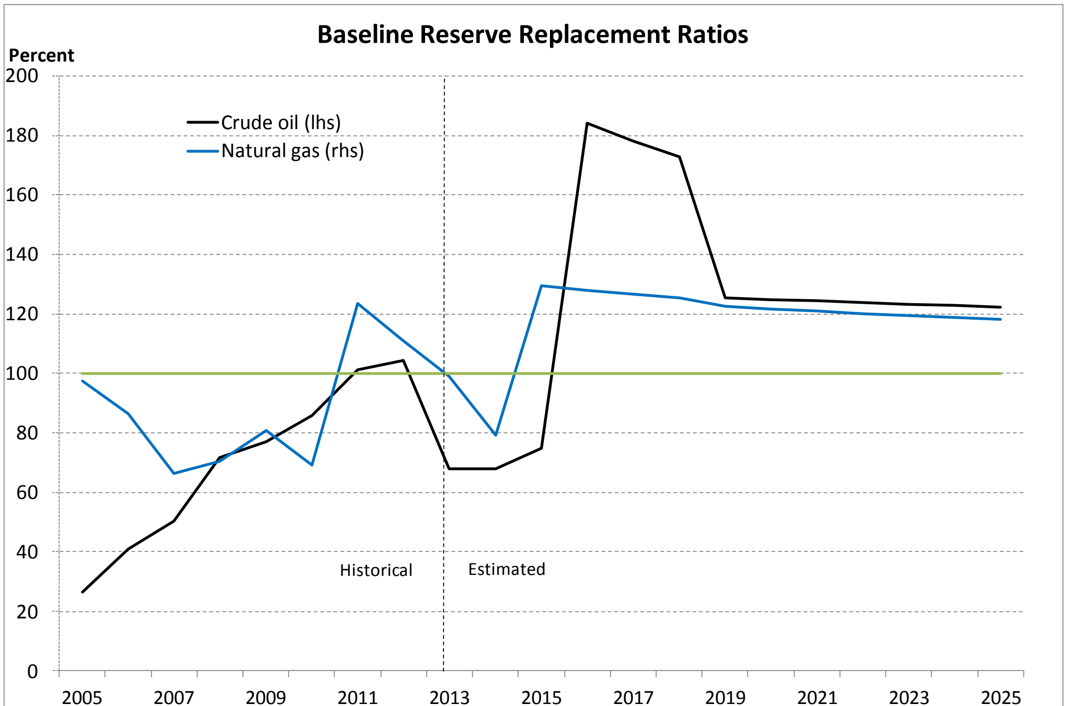
13. In our baseline scenario, we assume that the targets set by the government are achieved. Crude oil production would fall from 2.5 in 2013 to PEMEX's projection of 2.35 and 2.4 mmbd in 2014 and 2015, respectively. Production rises incrementally from there and reaches 3.0 mmbd by 2019 and 3.5 mmbd by 2025 (Figure 1). Reflecting PEMEX' s commitment to at least maintain production at 2.4 mmbd, we assume between 2016 and 2015 that at least that much is produced. Then between 2016 and 2019, any additional production above that level would likely come from existing and probable reserves that were included in Rounds 0 and 1. Between 2019 and 2025, we start to introduce production from shale and deepwater sources slowly, using the typically production curves in the chart above. If we keep the ratio of proven reserves to production constant at the 5-year historical average of 10.9 years, the RRR for crude oil would have to rise to an average of 159 percent between 2016 and 2019 and 128 percent between 2020 and 2025 (Figure 1).

- Natural gas production is assumed to rise from 6.5 bcfd to 8.0 bcfd by 2018 and 10.4 bcfd by 2025 (Figure 1), also consistent with authorities' projection. The proven reserves to production ratio are assumed to remain constant at the historical 5 year average of 5.5 years. At those rates the RRR of natural gas would have to average 126 percent between 2016 and 2019 and 120 percent thereafter (Figure 1).

Figure 1. Illustrative Baseline Scenarios



Source: SENER and IMF staff calculations



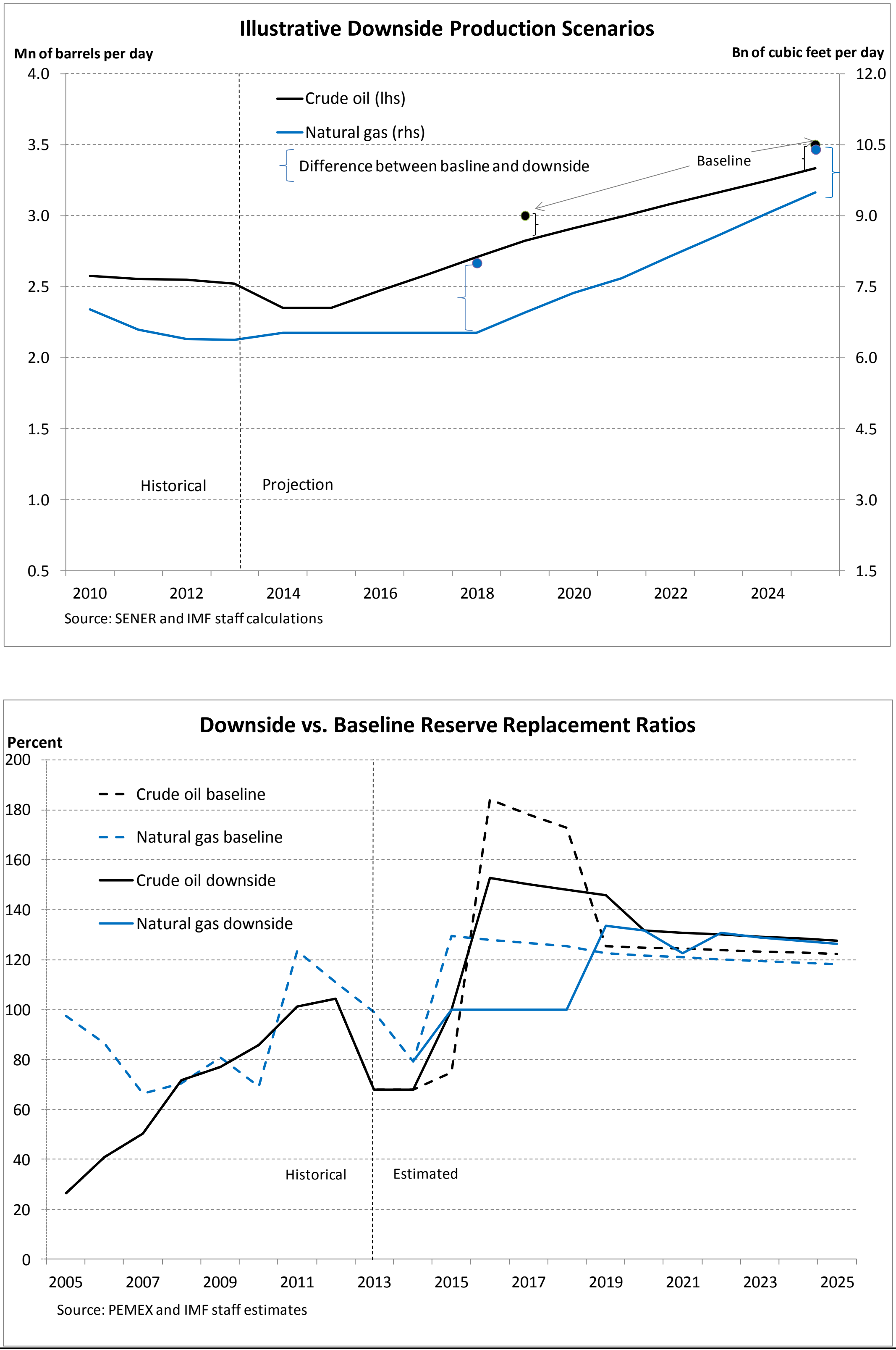
Source: PEMEX and IMF staff estimates

14. Between 2015 and 2019, additions to proven reserves will likely come from the existing fields and 2P reserves, which can be produced by Pemex and its partners or new entrants. The oil is likely to come from conventional fields and the application of secondary and enhanced recovery techniques on existing fields. Between 2020 and 2025, shale and deep water sources are likely to come into play that are developed and produced by firms winning fields from federal government auctions.

15. We construct a downside scenario which assumes the government's production goals are not met as scheduled. First, we assume that Pemex production in 2015 stays at the 2014 projected level of 2.35 mmbd, and this level continues between 2016 and 2025. From 2016 to 2019, any additional production above 2.35 mmbd is assumed to come from half of the 2P reserves in the Round 1 blocks announced on August 13, 2014 spread over the 4 years. Production does increase over this time, but only reaches 2.82 mmbd by 2019. From 2020 to 2025, other sources including conventional, shale, and deepwater contribute to production, with the latter two following the typically production schedule shown in Figure 4. Production rises to 3.33 mmbd by 2025 (Figure 2). We also assume that the proven reserves to production ratio stays constant at the historical 5 year average of 10.9 years. The scenario is equivalent to the government achieving its production golas, but with a delay of 2 years, i.e. 3.0 mmbd in 2021 vs. 2019 and 3.5 mmbd in 2027 vs. 2025. Under this scenario, the RRR for crude oil would have to average 149 percent between 2015 and 2019 and then increase to an average of 130 percent from 2019 to 2025 (Figure 2).

- Under a downside scenario, we assume natural gas production stays constant at the projected 2014 level of 6.5 bcfd between 2015 and 2018. This means no additions to production in the first few years, and effectively means that any additions to proven reserves over this time are only in crude oil not natural gas. Natural gas production only increases from 2019 to 2025, reaching 9.5 bcfd in the last year. Shale gas only contributes to production starting in 2021, consistent with the longer end of the 5 to 10 year range between auction and the start of production. The proven reserves to production ratio for gas are assumed to remain constant at the historical 5-year average of 5.5 years. In this scenario, the government's goal of 8.0 bcfd is only reached after 2021 and 10.4 bcfd in 2027 (Figure 2). The RRR of natural gas under this scenario would have to be 100 percent in the first period and 129 percent in the latter (Figure 2).

Figure 2. Illustrative Downside Scenarios

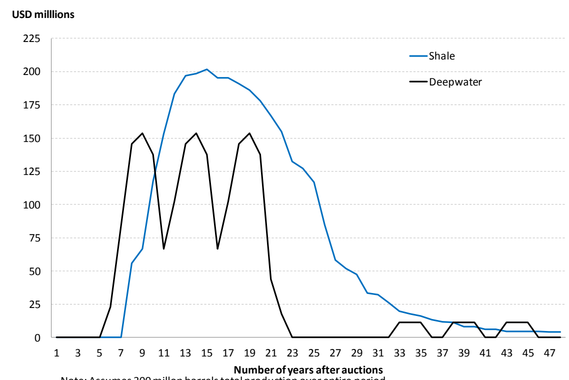


G. How Much Investment and FDI?

16. In order to estimate the amount of investment needed annually to achieve the higher RRRs, we need the amount of addition to reserves each year implied by the new RRRs, and a cost per barrel of crude oil or per million cubic feet per day of natural gas to develop the different types of projects.

- For the exploration of new conventional fields, the cost of finding crude oil and natural gas is about $20 per barrel according to the EIA in South America and the U.S.[1] Projects that used advanced recovery techniques to extract more oil or gas from existing fields cost between 15 to 25 dollars per barrel, according to discussions with industry analysts. We assume that cost for these two types of projects is the same for crude oil and natural gas, which is particularly true for associated natural gas—gas found in field where oil is also found.

Typical Capital Expenditures for Shale and Deepwater

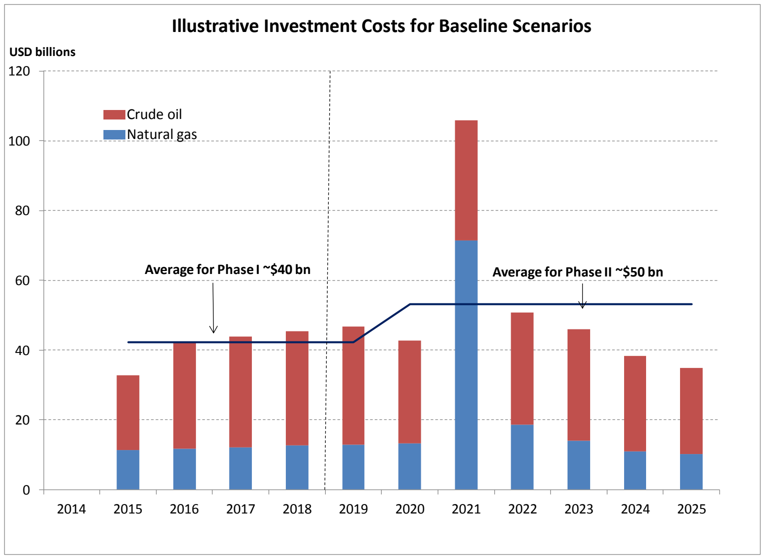


Note: Assumes 300 millon barrels total production over entire period
Source: Goldman Sachs

- For shale and deep water projects, we use cost curves provided by Goldman Sachs (see chart above). Their energy industry researchers used historical cost data from existing projects (like Eagle Ford in the U.S. and deep water fields in Brazil) to estimate the average cost of a typical project. The cost of shale development is about $11 to $20 per boe on average and deep water development at $9 to $20 per boe. We use Goldman's estimated cost curves in our analysis which better captures the timing of capital expenditures.

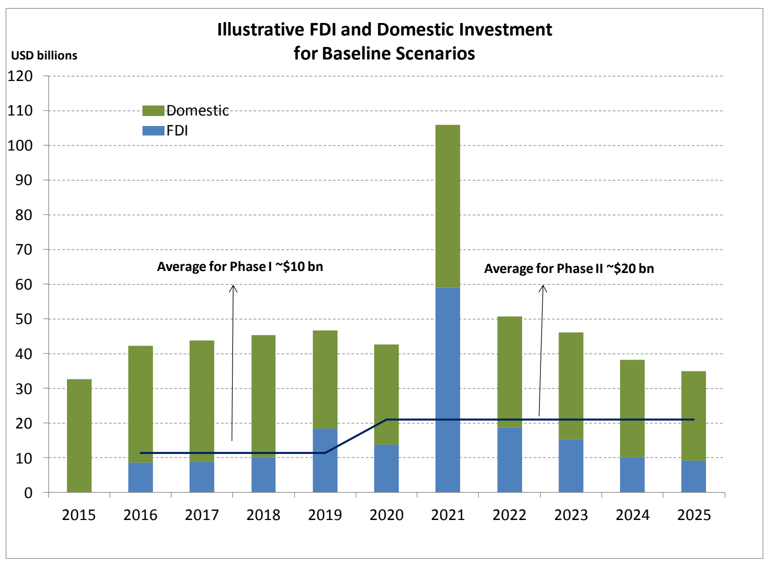
17. Given these assumptions, the first phase of development, between 2015 and 2019, is estimated to require investment of about $40 billion per year. For the second stage, between 2020 and 2025, about $50 billion per year is needed (see chart below). These investments include the roughly $25 billion per year already estimated in the capital expenditure plan for E&P of PEMEX. The hump in 2021 in the investment schedule reflects the timing of the increased investment for both shale and deepwater that results from the cost curves we use (see chart above). In our downside scenario with less production and addition to reserves, average annual investments needs are about 10 percent less per year.

[1] The EIA estimates these costs from data collected from major U.S. energy producing companies as of their 2009 reports.



18. To estimate what of this amount might be from foreign investment, we differentiate the two phases.

- From 2016 to 2019, PEMEX is likely to take the lead role in conventional fields and recovery, along with private partners or contracts with private firms. In this phase, the share of the investment costs borne by foreigners is likely to be smaller than projects in the second phase. We assume less than 30 percent of investment is from foreigners. Starting in 2016 we estimate that related-FDI will increase by about $10 to $15 billion from current levels (chart).



- For the second phase, 2020–2025, we assume that that the domestic content requirement will steadily increase from 25 percent to the target of 35 percent by 2025 as written in the law. For deepwater, a minimum of 20 percent participation by Pemex is required in trans-boundary projects. We estimate FDI will increase by about $10 to $15 billion from current levels between 2016 and 2019 and by $20 to $30 billion between 2020 and 2025. In our downside scenario, FDI would on average be about 20 percent less annually over the 10 years.

19. In order to compare our results, there is a wide range of analysts' estimates of the amount of investment and FDI that could result from the energy reform (see table). These estimates come from industry experts and surveys of interest in participation in projects. They range from a low of less than US$10 billion per year to a high of US$30 billion or more. Our estimates are more in line with the lower end of those ranges. Take note that we only estimate investments into the development of oil and natural gas fields, and do not account for the wider scope of the energy reform. Some analysts have considered the broader scope of the reform.

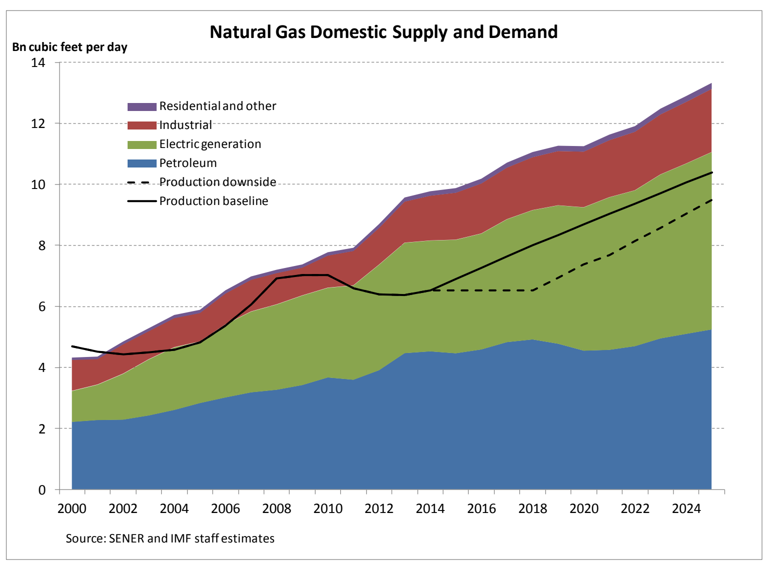
Estimates of FDI from different sources

Estimate by:	2015	2016	2017	2018	2019
Citigroup	7	17	22	18	11
Consejo Coordinador Empresarial	34	68	68	45	23
Pemex	16	38	46	37	22
ProMexico	4	7	6	4	2
International comparisons to Brazil and Colombia					
Weight of global greenfield FDI relative to weight in world GDP	10	21	21	14	7
FDI trends after energy reform	4	10	14	14	11
Average	12	27	29	22	13

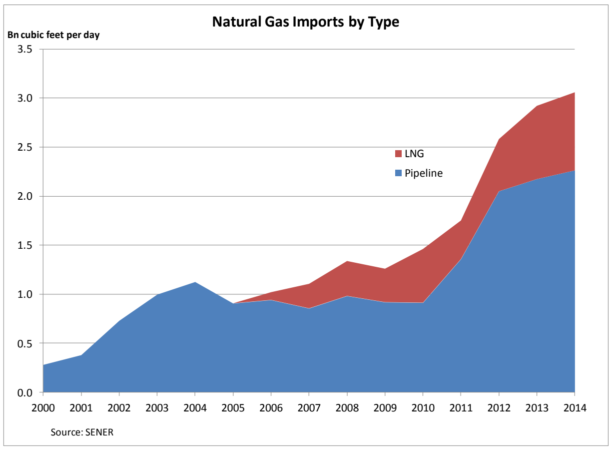
Source: Banamex

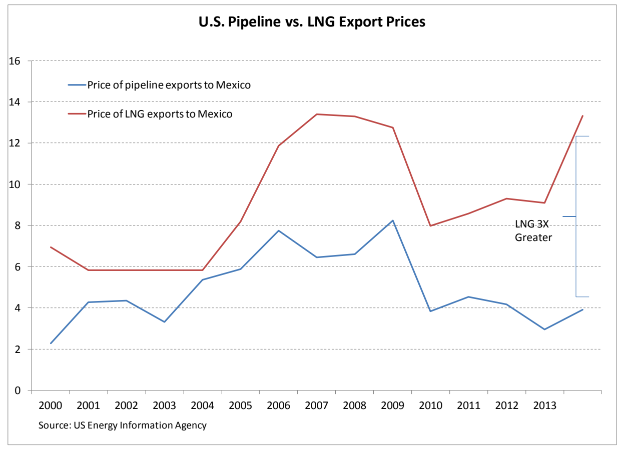
H. Natural Gas Imports and Transport

20. Although in our scenarios natural gas production increases, Mexico is projected to remain a net importer of gas. Since 2010, natural gas demand has been growing at 6.5 percent per year on average in real terms in contrast to the 2.4 percent average decrease in production. The Instituto Mexicano del Petroleo, the in-house institute of SENER, projects demand to continue to grow at an average annual rate of 3.9 percent between 2015 and 2025. In the baseline scenario, production grows at a rate of 4.3 percent per year (see chart), which implies that by 2025 estimate imports would fall 9 percent compared with 2013, but remain substantial at 2.9 bcfd. In the downside scenario, imports would increase by 24 percent by 2025 in relation to 2013

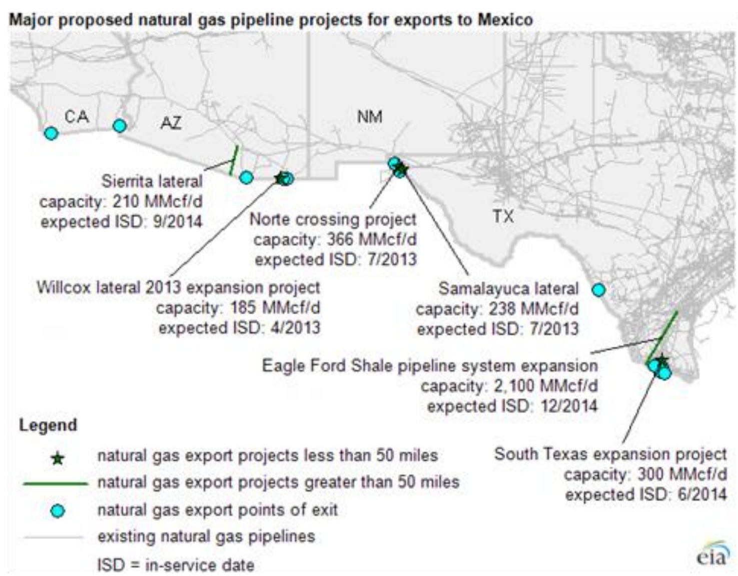


21. The majority of Mexico's natural gas imports are via pipeline from the U.S., but imports of the more expensive liquefied natural gas (LNG) have grown. Mexico began to import LNG in 2006, and imports peaked in 2010 at 0.55 bcfd (see chart). In 2013 LNG's share of natural gas imports had grown to a peak of 26 percent. For most of these sources, the prices of LNG gas are much higher than pipeline gas. In 2013, pipeline gas from the U.S. cost $3.9 per thousand cubic feet, while LNG cost $13.3 (see charts).





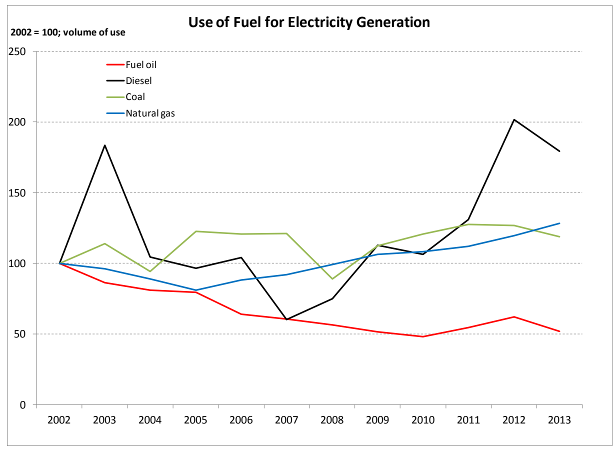
22. Increasing pipeline capacity to the U.S. is necessary to take advantage of the shale revolution in the U.S. U.S. pipeline gas prices have been falling over 50 percent since 2008, due in part to the increasing supply of natural gas from unconventional sources in the Bakken and Eagle Ford shale plays. The U.S. exported 1.8 bcfd to Mexico in 2013, but projects are in train to significantly increase that amount. According to industry analysts, between 2013 and 2016 about 5.2 bcfd in pipeline capacity is being built (see map). Delays in construction would delay Mexico's ability to take advantage of lower-priced U.S. gas.



23. The reforms and ambitious infrastructure plans by SENER aim to prevent future strains in the natural gas system. In 2013, the system experienced a significant increase in critical alerts, putting a strain particularly on industrial users and electricity generators. While these have eased, policies are geared towards preventing future stresses. The reforms change the governance of the pipeline system, so that an independent regulatory body, Cenegas, manages natural gas traffic to make the allocations more efficient. The transport and storage markets are now open to private participants, which will hopefully increase supply. Additionally, SENER has plans to build out the domestic pipeline infrastructure to connect to the pipelines to the U.S. and expand the transport of gas within Mexico.

I. Electricity Reform

24. Lowering natural gas prices will help to lower electricity prices, which could significantly improve firms' cost structure. The largest users of natural gas are electricity generators, as natural gas combined cycle plants have been the main choice for adding new generation capacity since the 1990's. In particular, private firms that generate power for themselves are projected by SENER to have the fastest growth in natural gas demand over the next decade. This will help to further displace diesel and fuel oil, which is costlier and more polluting than natural gas but remains the marginal source of generation (see chart).



25. The energy reforms also further opens up the generation market to competition. Firms that self-generate and independent power producers (IPPs) had already been allowed to compete with CFE to build and produce their own generating capacity. However, IPP s had to sell their electricity to CFE, and there was no mechanism for self-generators to sell their excess electricity to the market. Thus, the benefits of earlier reform accrued more to these self-generators than to the wider public, but that system is set to change. Over time, authorities are also considering expanding the scope of qualified users who can buy electricity in the wholesale market. The wholesale market is where end users can benefit more directly from lower natural gas and electricity prices.

26. Improvements to the grid and grid operations would also help to lower prices and improve service. Mexico suffers from an aging grid system with just under half of transmission lines more than 30 years old and less than 10 percent added in the last five years. CFE plans to expand the system by about 1 percent per year over the next decade. This has led to higher rates of electricity loss via distribution compared to other OECD countries. Additionally, prior to the passage of the reforms the management of grid traffic was operated by an entity within CFE, raising concerns about conflict of interest in prioritizing the dispatch of power plants to the grid. To address this, Cenace will be transformed into an independent system operator. Under the new structure, Cenace can better dispatch plants based on efficiency (lowest marginal cost) or emergency needs. Additionally, the CRE will set the tariffs on transmission, distribution, and ancillary services. These tariffs will be charged to all users of the grid, and CRE can provide incentives to reduce the losses of electricity during transmission.

27. The conversion of CFE into a state productive enterprise will give it more operational and budgetary autonomy. It will also have an expanded ability to contract with third parties that potentially could be more efficient at providing transmission and distribution services. CFE is also charged with adopting international standards for the management of state enterprises aimed at making its operations more efficient and lowering costs. This increased independence, as in the case of Pemex, will hopefully lead to an improved ability to investment in energy infrastructure.

J. Conclusion

28. The energy reform is comprehensive and has the potential to reshape Mexico's economy to support faster growth, better living standards, and greater energy security. In the short-run, it is a defensive reform aimed at overcoming the risk of falling hydrocarbons production and improving the outlook for fiscal revenues. In the medium- to long-run, the reforms allow the country to tap its potential in shale and deepwater, as well as to provide the incentives to reduce domestic energy costs and improve services.

29. While the focus of market attention is on deepwater and shale, in the short-run improvements in recovery and development of existing fields is crucial. Authorities have wisely focused the majority of Round 1 on auctioning 2P fields that could yield hydrocarbons quickly. Additionally, Pemex will now have more freedom to partner with third parties to increase investment and import technologies to enhance its production.

30. The legislative hurdles have been tackled, but implementation risks remain. Round 1 is critical and will set the tone for future rounds, and many changes to regulations and institutions still have to be made. Delays or problems with implementation that dampen investor confidence will have consequences. Our downside scenarios show a stylized illustration of the lower production path and commensurate lower investments needs and FDI. These could have knock on negative impacts on exports and fiscal revenues.

31. Managing expectations about the shale and deep water potential is critical. Patience is needed given that it will take a long time before meaningful production can be extracted from these sources.

32. While there has been so much focus on exploration and production, the pipes and the grid are very important for growth. Lower energy costs and improving services will reap benefits on the manufacturing sector and the broader economy. Planned natural gas pipeline projects will help Mexico further lower its dependence on LNG, diesel, and fuel oil. Independent system operators for natural gas and electricity will help to reduce critical alerts and enhance service delivery.

33. Besides opening up the energy markets, Pemex and CFE needed to be shaken up to improve their efficiency, costs, and ability to invest in infrastructure. Transforming them into productive state enterprises and reducing their fiscal burdens are the first steps in this path.

References

Luna, Sergio, and Manriquez, Jorge Luis. Energy Reform and Investment Flows: How Much? When?. Citi Economics Research, March 7, 2014.

Mattar, F., Murti, A. et al. Mexican Energy Reform. Goldman Sachs Equity Research, January 6, 2014.

Mexican Senate. Opinions of the Constitutional Commission on the Energy Sector.

Morse, Ed. Mind the Gulf: What does the North American energy revolution mean for Latin America? Presentation at the Inter-American Dialogue, April 2014.

PEMEX. Mexico's Energy Reform & PEMEX as a State Productive Enterprise. August, 2014 presentation.

PEMEX. Investor Presentation. May, 2014.

Press releases of Round 0 and 1 results (SENER website)

Secondary laws on the Mexican Energy Reform (SENER website).

Secretary of Energy, Mexico. Prospects of the Electricity Sector, 2013–2027.

Secretary of Energy, Mexico. Prospects of the Natural Gas and L.P. Gas, 2013–2027

U.S. Energy Information Agency. Mexico Country Briefing. April 24, 2014.

U.S. Energy Information Agency. Mexico Week. May 16, 2013.

U.S. Energy Information Agency. U.S. Natural Gas Exports to Mexico Reach a Record High in 2012. March 13, 2013.

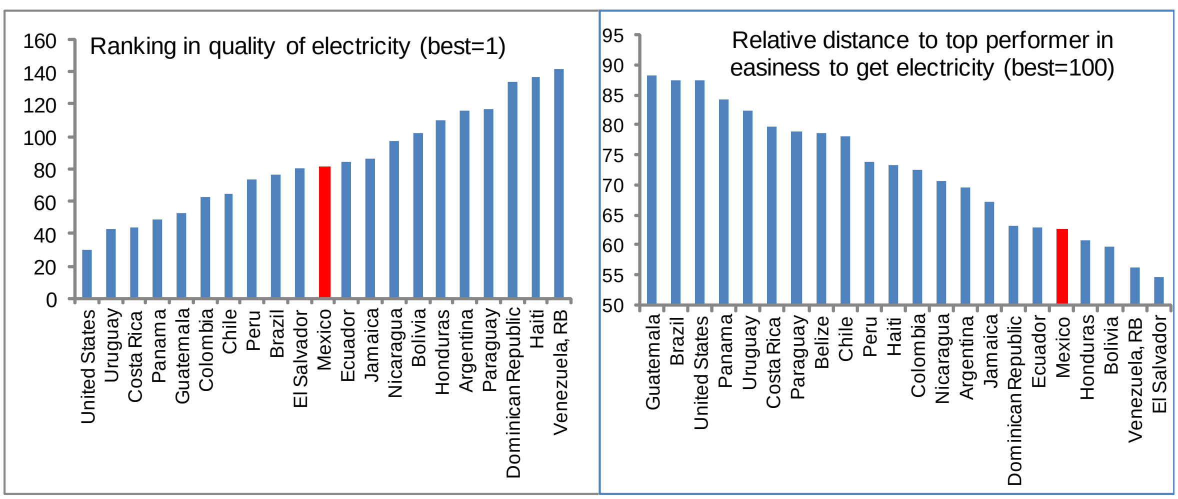
MADE IN MEXICO: THE ENERGY REFORM AND MANUFACTURING OUTPUT[1]

A. Introduction

1. Manufacturing activity in Mexico surged after the signing of the North America Free Trade Agreement, NAFTA. Since then, Mexico has attracted or created world-class performers in the manufacturing sector. Greater integration and lower trade barriers with its largest trading partner brought about new investment, new technology, and thus higher output. Today, manufacturing exports account for about 80 percent of total exports, of which about a third corresponds to automobiles.

2. Nevertheless, the cost and quality of electricity, and more recently temporary shortages of natural gas, are drags to competitiveness of the sector. Mexico ranks consistently low on indicators of global competitiveness regarding the costs and quality of electricity. And limited investment in infrastructure has led natural gas pipelines to operate close to maximum capacity and unable to accommodate rising demand, including from the manufacturing sector (Bank of Mexico, 2013).

Quality and Easiness to Get Electriciy in Selected Countries



Source: World Economic Forum Competitiveness Report (2014) for quality of electricity and Doing Business Report (2014) for easiness to get electricity, which looks at procedures, time, and cost required for a business to obtain a permanent electricity connection for a newly constructed warehouse.

[1] Prepared by Fabián Valencia and Jorge Alvarez. The authors thank Dora Iakova, Herman Kamil, Robert Rennhack, Ernesto Revilla, Alberto Torres, Alejandro Werner, and seminar participants at the IMF, Secretaría de Hacienda y Crédito Público, and Banco de México for comments and discussions.

3. The recent energy reform has the potential to alleviate these bottlenecks and provide a new impetus to manufacturing activity in Mexico. The reform opens the hydrocarbons and electricity sectors to private participation in different modalities. Increased investment will help improve existing infrastructure, efficiency in the sector, and the availability of natural gas. As these changes take place, Mexican manufacturing firms will benefit from lower electricity prices.

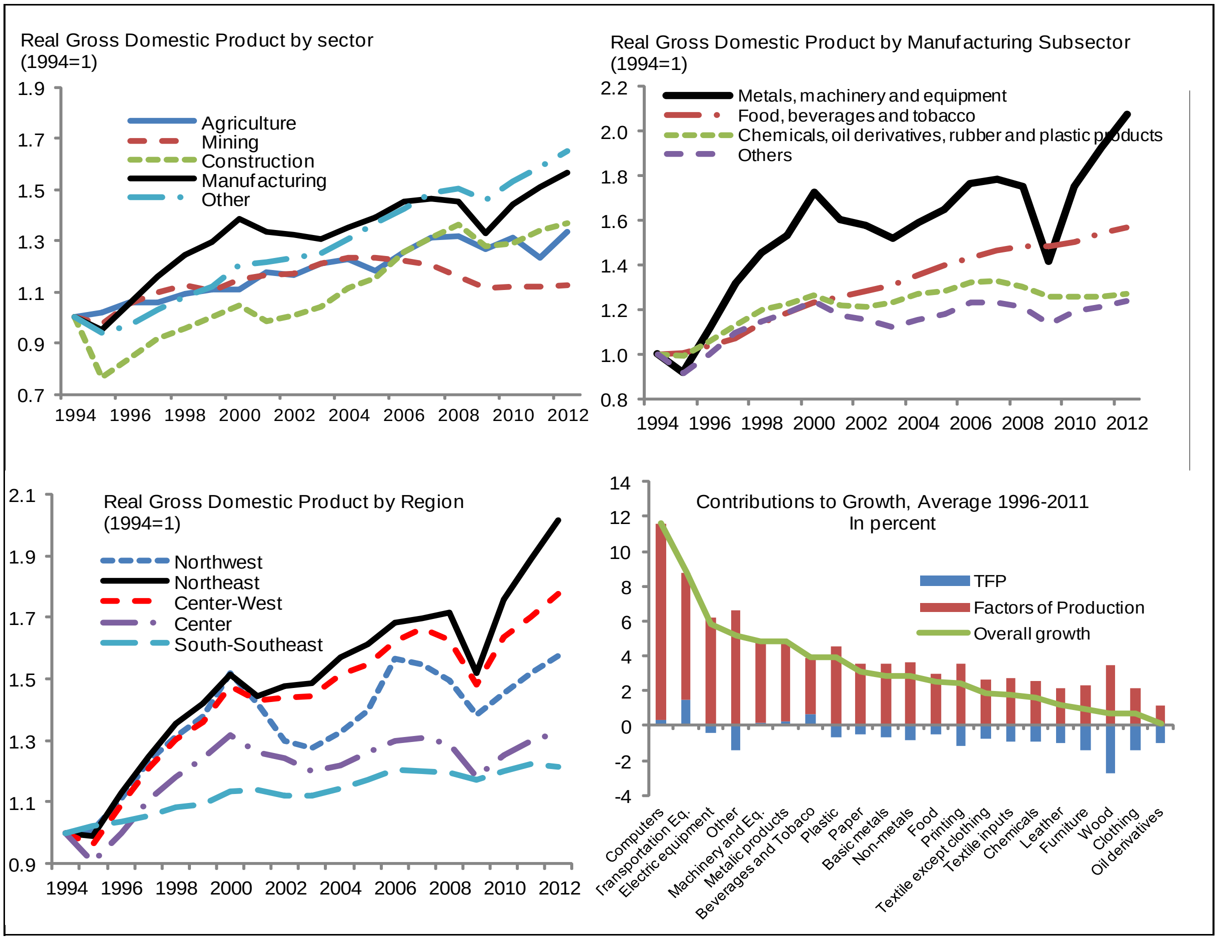
4. This paper aims at quantifying the impact of the energy reform on Mexican manufacturing activity through its impact on the cost of energy inputs. It is part of a broad agenda aiming at quantifying the effects of the recently enacted package of structural reforms on the Mexican economy. The next section presents stylized facts about the industry and its evolution since NAFTA, followed by an assessment of the economic impact of the reform, starting with estimates of elasticities of manufacturing output to energy prices and the scope for the reform to affect energy prices in Mexico. We then assess spillovers within the manufacturing industry, to the rest of the economy, and within the different regions in Mexico, followed by concluding thoughts.

B. The Mexican Manufacturing Sector Since NAFTA

5. Manufacturing activity in Mexico surged after NAFTA, particularly in the production of transportation equipment. Mexico's car production tripled since NAFTA and today Mexican cars account for about a third of U.S. auto imports, recently surpassing Japan to become the second biggest car exporter to the United States. And Mexico also supplies one third of all U.S. imports of auto-parts. The most recent announcements include Daimler Benz and BMW, with combined estimated investments surpassing US$2 billion.

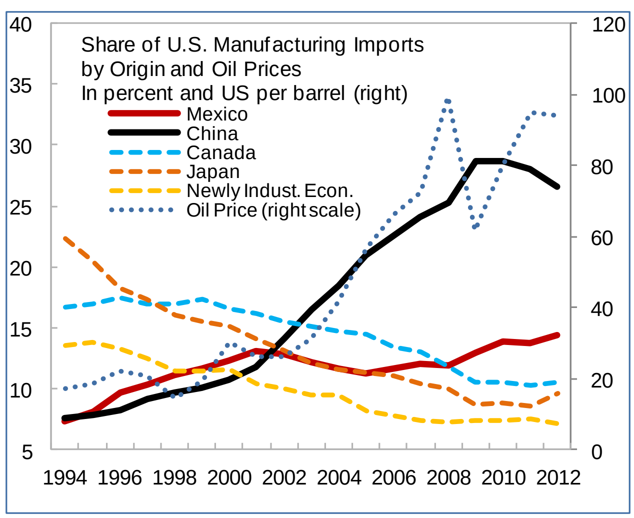
6. Growth in manufacturing was, however, uneven across sectors and regions. The expansion was notoriously more pronounced in manufacturing than in other sectors, at least initially. But even within manufacturing, growth was highly uneven with transportation equipment being a clear outlier. Moreover, when looking at contributions to growth, transportation equipment is the only sector with meaningful contributions from total factor productivity, with almost a fifth of overall growth. Heterogeneity in performance across sectors translated into geographical disparities in performance, as regional manufacturing clusters implied much stronger performance in the north than in the south.

Mexican Manufacturing Output since Nafta



Source: Instituto Nacional de Estadisticas y Geografia (INEGI), and staff calculations.

7. Mexico's manufacturing sector faced also important headwinds with the rising importance of China in the global market. The rise of Mexico's manufacturing sector was hard hit by China's rise on the global stage when it joined the WTO in 2001 (Kamil and Zook, 2012). China was able to crowd out Mexican exports in the U.S. market because Mexico had lost its advantage in several labor-intensive manufacturing sectors in which it specialized. But almost as quickly as it stumbled, Mexico regained its footing and began to claw its way back. Rising oil prices may have contributed to an inflection point in Mexico's U.S. market share around 2005 by raising the importance of proximity to the U.S. market as a competitiveness factor as transportation costs increased.



C. The Energy Reform: How Much of a Boost for Mexican Manufacturing?

8. While the energy reform can affect manufacturing production through several channels, we focus on its effect through lower energy costs. The reform can lead to higher capital accumulation as new investment arrives. And with this new investment, technology transfers may also open the door to increases in overall productivity. However, at this juncture, there is substantial uncertainty regarding these broader channels, but it is possible to infer how manufacturing output would respond to lower energy prices from past data. Complemented with estimates of the potential reduction in energy prices, these estimates can help us measure the economic effects of the reform through its impact on energy prices and manufacturing activity.

How Sensitive is Manufacturing Output to Changes in Energy Prices?

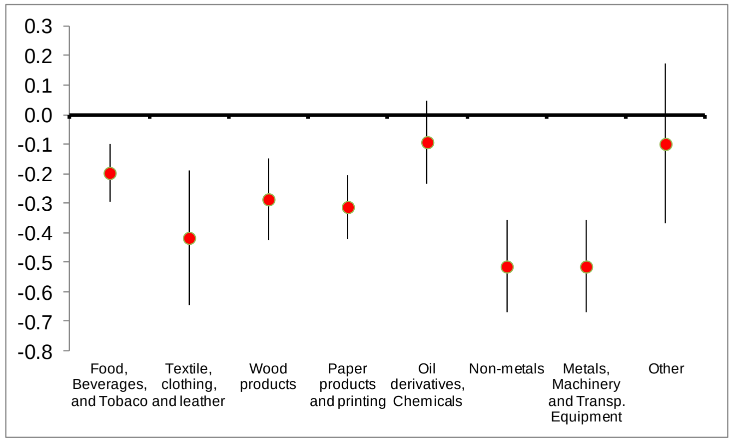
9. We estimate the response of manufacturing output to changes in energy prices using a simple panel regression analysis. The left-hand side corresponds to the real gross domestic product for manufacturing industry *i*, in state *j*, in year *t*. The right hand-side includes a lag of the dependent variable, the variables of interest: the lagged change in electricity prices, *EL*, in natural gas prices, *NG*, and oil derivatives prices, *OD*. The focus on these particular energy inputs arises from their importance in industrial production (Table 1). The change is computed after deflating energy prices with the consumer's price index to reflect changes in real terms. The regression includes controls, *X*, in the equation below, that have been found to be important in explaining manufacturing activity, including unit labor costs, the real effective exchange rate, the cost of capital, industrial production in the United States, and other variables, all in first difference form. The regressions include also fixed effects at the sector-state pair level, δ_{ij}.

$$\Delta \boldsymbol{y_{ijt}} = \boldsymbol{\alpha_0} + \boldsymbol{\beta_0} \Delta \boldsymbol{y_{ijt-1}} + \boldsymbol{\beta_1} \Delta \boldsymbol{EL_{t-1}} + \boldsymbol{\beta_2} \Delta \boldsymbol{NG_{t-1}} + \boldsymbol{\beta_3} \Delta \boldsymbol{OD_{t-1}} + \boldsymbol{\beta_4} \Delta \boldsymbol{X_{t-1}} + \boldsymbol{\delta_{ij}} + \boldsymbol{\varepsilon_t}$$

10. Among energy inputs, electricity prices have the largest impact on manufacturing output, with an elasticity of up to -0.28. Tables 2 and 3 show the estimated elasticities under various specifications for the most important energy sources. The elasticities range from -0.11 to -0.28. For natural gas, the elasticities range from -0.04 to -0.07. The independent effect of natural gas, aside from its impact through electricity prices, comes from the fact that about 18 percent of the national demand for gas comes from the industrial sector, including manufacturing. The impact of a one percent change in electricity prices far exceeds the one from natural gas prices. Interestingly, oil derivatives come up with a positive sign. While in principle this positive coefficient could be picking up the increased importance of proximity to U.S. as competitiveness factor in a world with rising oil prices and transportation costs (Section I), it remains positive even after controlling for international oil prices. Nevertheless, its statistical significance weakens as additional controls are included (Table 2, columns 5–7; Table 3, column 3)

11. Changes in electricity prices have a larger effect on the sector of metals and transportation equipment, which includes the auto industry. Naturally, not all subsectors within manufacturing are affected equally, as shown in the figure and in more detail in Table 4. The figure shows the elasticity for each subsector (red dot) and its confidence interval (vertical line across the dot). Clearly, the elasticities vary widely, with the chemical sector exhibiting a -0.1 value and not statistically significant, to the metals and transportation equipment with a highly statistically significant elasticity of -0.51. This is almost twice as large as the -0.28 average elasticity for the whole manufacturing industry discussed above. But this is not entirely surprising, given the importance of electricity as an energy input for this section shown in Table 1.

Elasticities of manufacturing output to elasticity prices by



Source: INEGI and staff calculations.

By How Much Can the Reform Reduce Energy Prices in Mexico?

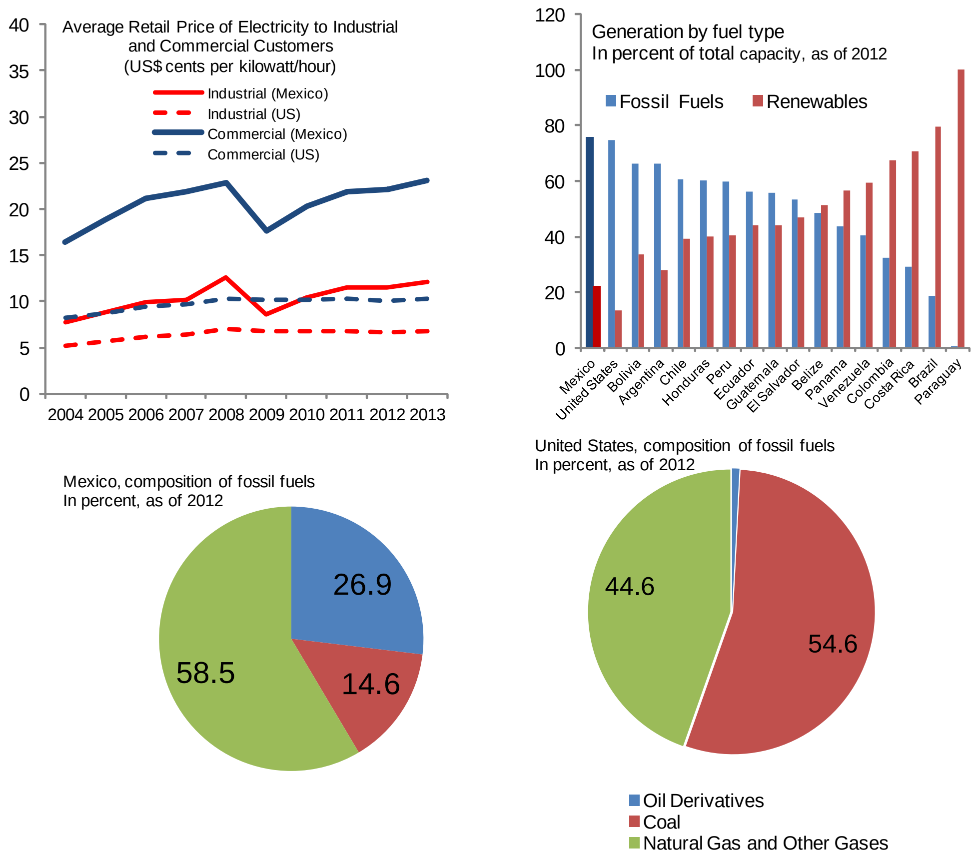
12. There is scope to reduce generation costs of electricity in Mexico by substituting fuel oil for natural gas in electricity generation. Electricity tariffs for commercial and industrial users in Mexico are roughly twice as high as those in the United States. But both rely in similar magnitudes—at about 75 percent of total generation capacity—on fossil fuels. However, one dimension in which these countries differ significantly is in the importance of oil derivatives within fossil fuels. Mexico relies much more on oil derivatives, mostly fuel oil, while the U.S. on coal, which is substantially less expensive.

13. Fuel substitution can potentially lower electricity prices on average by about 13 percent, with competition and efficiency gains bringing in further reductions. The shale gas boom in the U.S. has driven prices of natural gas down significantly, and for the last few years a sizable gap between the price of crude oil—and its derivatives, including fuel oil—and natural gas has persisted. Under the current electricity pricing mechanism in Mexico, if fuel oil were to be substituted for natural gas, industrial and commercial tariffs would go down by about 13 percent.[2] Given existing plans for pipeline investments, and conversion of fuel oil plants to operate with gas, it

[2] The current pricing mechanism in Mexico contemplates monthly adjustments for industrial users according to the evolution of fuel prices and inflation using weights for each fuel determined by its importance in electricity generation. Because the empirical analysis is conducted with prices in real terms, the inflation component in the adjustment formula is irrelevant for our analysis. Under this scheme, and given that fuel oil represent 18.1 percent of total generation, an immediate substitution of fuel oil for natural gas (about 71 percent cheaper than fuel oil) would imply, ceteris paribus, a reduction of about 13 percent in electricity prices (0.181*-0.71).

seems feasible to obtain these reductions within five years.[3] Strictly speaking, this substitution can be done without the energy reform. However, by attracting private investment in low-cost electricity generation, the reform makes it more likely that the gains from this substitution become permanent, and thus reversals—as the one seen in 2010/2011 (Chapter I)—less likely. Additional reductions could arise from increased efficiency. Energy losses in Mexico are high for international standards, which in part come from an aged transmission and distribution infrastructure. With the reform, new investment and the ability for transmission and distribution lines to be operated and maintained—although ownership will still be public—by private companies is possible. This has the potential to lead to efficiency gains which could help reduce electricity prices further. Assuming convergence to U.S. prices as a limiting case, these gains could lead to a reduction of about 50 percent in commercial and industrial electricity prices in total.

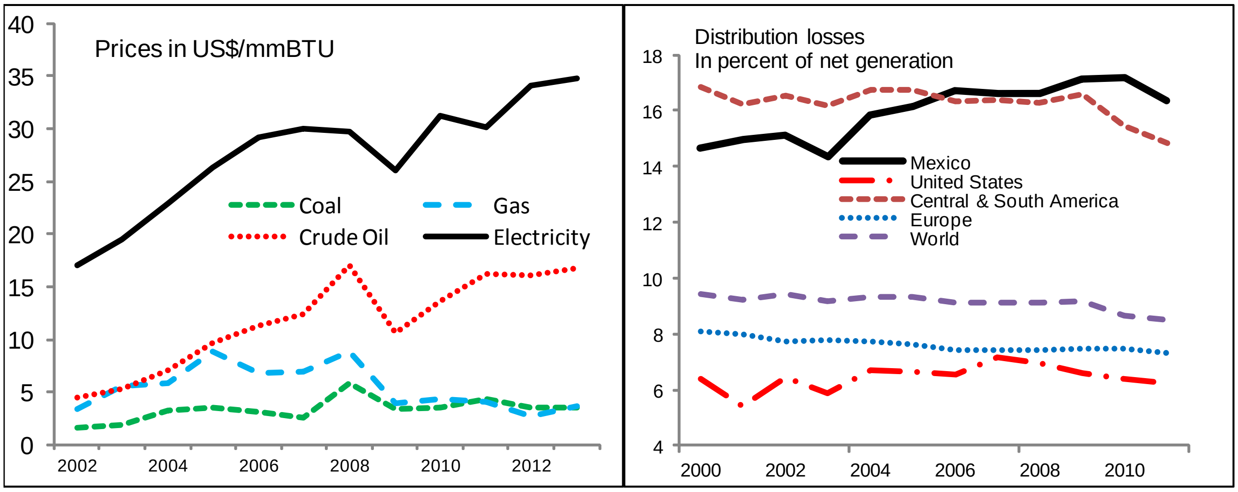
Electricity Prices and Generation in Mexico and United States



Source: U.S. Energy Information Administration, Secretaria de Energia de Mexico, and staff calculations.

[3] In July of 2014 Pemex awarded the construction of Los Ramones II-Norte, part of a large pipeline project of 1,200 Km from Texas to Guanajuato with capacity to transport 2,100 million of cubic feet per day by 2016, more than doubling the current U.S. gas import capacity. At the same time, the Federal Electricity Commission announced recently a plan to convert 7 fuel oil-based electricity generation plants to operate with natural gas by 2016.

Energy Prices and Energy Losses.



Source: Statistical Review of World Energy - BP (2014), Secretaria de Energia de Mexico, Instituto Nacional de Estadisticas y Geografia de Mexico, and U.S. Energy Information Administration (2011).

14. **Increasing the supply of natural gas to be used in electricity generation would come first from additional imports from the United States**. Since 2012, shortfalls of natural gas, explained by lack of spare capacity in gas pipelines to accommodate shocks and increasing demand, has affected the manufacturing sector importantly. Estimates by the Bank of Mexico suggest that without these shortfalls, GDP growth in 2013Q2 in annual terms would have been -0.4 and not -0.7 percent (Bank of Mexico, 2013). For the more immediate future, the potential of the energy reform to lower electricity prices and to avoid shortfalls in supply lies in increased investment in infrastructure to increase the capacity of the pipeline system to import more gas from the U.S. Several private projects are already underway (footnote 3 and Chapter I), and under the reform, all are required to provide open access, which will reduce the likelihood of bottlenecks in supply.

Real Effects of Lower Electricity Prices

15. **Should a reduction in electricity prices in the ranges shown above materialize, manufacturing output could increase up to 14 percent and overall GDP up to 2.2 percent**. The estimated elasticities imply that manufacturing output could increase between 1.4 and 3.6 percent if a reduction in electricity prices of 13 percent materializes. Furthermore, the increase in manufacturing output could reach 14 percent if prices were to converge to U.S. levels. For the economy as a whole, these impulses for manufacturing activity imply an increase in real GDP

Economic Impact of a Reduction in Electricity Prices

	Lowest	Highest
Elasticities (from Table 1)	-0.11	-0.28
	In percent	
Scenario 1: Substitution of fuel for natural gas		
Increase in manufacturing output	1.4	3.6
Increase in overall GDP	0.2	0.6
Scenario 2: Convergence to U.S. Levels		
Increase in manufacturing output	5.5	14.0
Increase in overall GDP	0.9	2.2

Note: Scenario 1 assumes a reduction in electricity prices of 13 percent, consistent with fuel oil being substituted by natural gas. Scenario 2 assumes convergence of electricity prices for industrial and commercial users to U.S. levels.

Source: National authorities and staff calculations.

of up to 0.6 percent and up to 2.2 percent for each scenario respectively, given today's share of the manufacturing sector in the economy. These level effects could materialize over the horizon that takes electricity prices to exhibit these reductions. As mentioned before, it is reasonable to expect the estimated gains under scenario 1 to materialize over 2016–2019. Timing of convergence of prices to U.S. levels is more uncertain because it requires reducing energy losses in transmission and distribution which is more challenging. Nevertheless, the scenario offers a benchmark of how large the effects over the long-run can be.

16. Increased supply of natural gas could allow substituting LPG and reduce imports of LNG; however, the effect of the reform on other energy prices is unclear. The industrial sector in Mexico consumes about 10 percent of total LPG demanded in the country, which if substituted for natural gas, it could provide an additional impetus to growth in manufacturing. Table 2 shows an elasticity of about -0.09 for LPG prices, but this number may be capturing demand effects as well, and thus it should be interpreted with caution.[4] And more broadly, increased availability of natural gas imported through pipelines can reduce and possibly even eliminate, in the long run, the need to import it in liquid form (LNG). Estimating the impact of the energy reform on oil and oil derivatives prices is more complex because those are commodities which are influenced by global demand and supply.

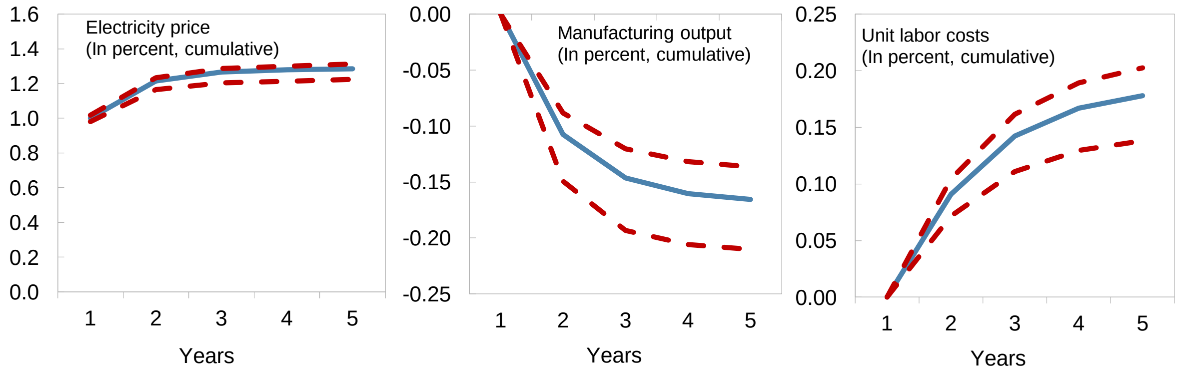
D. Are There Additional Indirect Effects Through Spillovers?

17. To allow for endogenous responses of unit labor costs and assess spillover effects we turn to a panel vector autoregression framework (VAR).[5] The results shown in the previous section highlight the direct impact of changes in energy prices on manufacturing output. However, there may be indirect effects that could imply lower or higher total effects on manufacturing output from changes in energy prices. For instance, unit labor costs may react to changes in energy prices, analogously to how they react to oil-price shocks (Blanchard and Gali, 2007), because of a potential substitution effect that induces an increase in labor demand or to labor supply channels associated with higher costs of living if changes in energy prices are passed to prices of good and services. Similarly, a subsector within manufacturing may respond directly to energy prices and indirectly through its dependence on other subsectors. Using the same logic, we explore regional spillovers. We focus our attention on electricity prices which as shown before are the ones with the largest impact on output.

[4] LPG represents less than 3 percent of energy inputs in the industrial sector and for this reason the estimated elasticity would seem high, suggesting that it may be capturing also the impact of LPG prices on manufacturing through its effect on demand.

[5] Appendix A provides technical details about the VAR specification. A more detailed technical discussion and several robustness exercises are also provided in Alvarez and Valencia (forthcoming).

Impulse response functions to a rise in electricity prices



Note: Impulse response functions (solid blue) are calculated for a period of 5 years with a shock of 1% to electricity prices. 90% confidence interval bands (dashed red) are based on parametric bootstrapped standard errors.

18. **Allowing unit labor costs to respond endogenously to changes in electricity prices amplifies the response of output**. The figure above shows the cumulative response to a 1 percent change in electricity prices both on manufacturing output and unit labor costs in the manufacturing sector. Manufacturing output responds directly to changes in electricity prices. This is the impact effect measured in period 2 in the figure, which would be comparable to the panel regressions in the previous section. However, manufacturing output also responds to the change in unit labor costs, which as the figure shows it is induced by changes in electricity prices. As a result, the direct effect of changes in electricity prices on manufacturing output gets amplified by the indirect effect electricity prices has through unit labor costs. By the fifth year, the cumulative effect of an electricity price shock on manufacturing output is about 50 percent larger than the impact effect.

19. **Nevertheless, under the employed methodology, we do not find statistically significant evidence of regional and sectoral direct spillovers**. Appendix Figure 1 shows the impulse responses of manufacturing output in each manufacturing subsector as well as in other sectors in the economy to changes in electricity prices. The figure shows two impulse responses in each chart, one corresponding to a model with (dotted purple) and without direct spillovers (solid blue). Spillovers refer to direct dependence of output in one sector to output in a difference sector, with regional spillovers defined analogously. This is done by restricting, in the no-spillovers case, the relevant coefficients to zero. Evidence of spillover effects would show up through a divergence of the two lines. While the figure shows that the lines do differ in several cases, they are always within the 90-percent confidence bands (dashed red lines), suggesting that the difference is not statistically significant. A similar conclusion arises in the analysis looking at regional spillovers.

20. **Several reasons can explain the lack of statistical evidence of direct spillovers**. First, there could be substantial crossectional and time variation in the spillover coefficients. Second, some interdependence can happen simultaneously, which implies that the impact effect already captures any additional amplification from spillovers. And third, spillovers through direct interdependence may appear weak given the uneven performance in past data across

manufacturing subsectors and regions. In sum, direct spillovers of the kind explored in this paper and under the chosen methodology do not appear statistically strong. These results are however not conclusive given the caveats noted above.

E. Concluding Remarks and Policy Implications

21. The energy reform is likely to have important real effects through its impact on manufacturing activity through lower electricity prices. These effects would come on top of the direct effects on growth that would arise from increased investment and production in the energy sector, for instance, from oil and gas exploration and extraction. Other factors, such as technology spillovers and increased foreign direct investment in manufacturing as the sector becomes more competitive could amplify the effects estimated in this paper.

22. In terms of policy priorities, increasing gas pipeline capacity to allow larger natural gas imports from the U.S. will yield the most immediate gains. In addition, existing fuel oil-based plants would need to be adapted to operate with natural gas. This would allow collecting the low-hanging fruit associated with substitution of fuel oil for natural gas in electricity generation. As the reform starts attracting private investment in low-cost electricity generation, the gains from fuel substitution are more likely to become permanent. Further gains will follow from increasing availability of gas throughout the country by an expanded network of pipelines.

23. A strong regulator is critical to ensuring competition in electricity generation and thus making any reduction in electricity prices long-lasting. To this end, synergy with the antitrust reform will play an important role. The new antitrust framework should help ensure an efficient opening of the sector to private investment to ensure healthy competition.

24. For gains in efficiency, it is critical that the operation of transmission and distribution lines encompass the right incentives to improve existing infrastructure. As distribution and transmission lines will remain property of the state, gains in efficiency will arise from having in place the right incentives for the new administrator of the infrastructure to invest and lower the high technical losses in the system. A word of caution is needed. Reducing distribution losses will be challenging and thus the gains from increased efficiency, while in theory are important, are not guaranteed.

References

Alvarez and Valencia, forthcoming. "Made in Mexico: Energy Reform and Manufacturing Growth." IMF Working paper.

Bank of Mexico, 2013. "Efectos del Desabasto de Gas Natural sobre la Actividad Económica." Informe sobre la Inflación, Julio–Septiembre 2013, pp. 31–34.

Blanchard, O. J., & Gali, J. (2007). The Macroeconomic Effects of Oil Shocks: Why are the 2000s so different from the 1970s? (No. w13368). National Bureau of Economic Research.

Kamil, H & Zook, J., 2012. "What Explains Mexico's Recovery of U.S. Market Share?" IMF Article IV Consultation. Selected Issues, 16–25.

Table 1. Energy Consumption (in Petajoules) of the Industrial Sector

	2010	2011	2012
Industrial sector total	**1,381.1**	**1,492.3**	**1,530.6**
Electricity	34.2%	33.6%	34.5%
Natural Gas	35.3%	35.2%	35.8%
Oil derivatives	17.0%	15.5%	15.6%
Others	13.5%	15.8%	14.0%
Auto industry	**10.5**	**12.7**	**14.4**
Electricity	68.3%	60.0%	60.4%
Natural Gas	19.9%	28.1%	28.7%
Oil derivatives	11.8%	11.9%	10.9%
Others	0.0%	0.0%	0.0%

Source: SENER. Balance Nacional de Energía.

Table 2. Estimates of Elasticities of Manufacturing Output to Energy Prices

Dependent variable: Δy_{ijt} Sample: 1998–2012, annual	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δy_{ijt-1}	0.036	0.029	0.030	0.031	0.005	0.005	0.005
	(0.040)	(0.040)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)
$\boldsymbol{\Delta EL_{t-1}}$	**-0.114**	**-0.141**	**-0.141**	**-0.167**	**-0.263**	**-0.269**	**-0.283**
	(0.032)***	**(0.032)*****	**(0.032)*****	**(0.039)*****	**(0.040)*****	**(0.040)*****	**(0.041)*****
$\boldsymbol{\Delta NG_{t-1}}$	**-0.068**	**-0.049**	**-0.049**	**-0.045**	**-0.048**	**-0.047**	**-0.039**
	(0.014)***	**(0.014)*****	**(0.014)*****	**(0.014)*****	**(0.014)*****	**(0.014)*****	**(0.014)*****
$\boldsymbol{\Delta OD_{t-1}}$	**0.111**	**0.094**	**0.093**	**0.074**	**0.054**	**0.048**	**0.019**
	(0.019)***	**(0.018)*****	**(0.018)*****	**(0.027)*****	**(0.027)****	**(0.027)***	**(0.029)**
Δulc_{it-1}		-0.228	-0.228	-0.219	-0.066	-0.060	-0.063
		(0.045)***	(0.045)***	(0.047)***	(0.050)	(0.050)	(0.050)
$\Delta REER_{t-1}$			-0.008	-0.044	-0.298	-0.310	-0.317
			(2.934)	(4.620)	(5.312)***	(5.282)***	(5.421)***
$\Delta WTI\ (nominal)_{t-1}$				0.022	0.046		0.074
				(2.158)	(2.174)**		(2.449)***
$\Delta WTI\ (real)_{t-1}$						0.053	
						(2.222)**	
$\Delta U.S.IP_{t-1}$					0.559	0.561	0.496
					(7.378)***	(7.372)***	(7.453)***
$\Delta U.S.r_{t-1}$							-0.674
							(0.255)***
Constant	0.988	1.018	1.024	1.045	0.967	1.089	0.956
	(0.124)***	(0.123)***	(0.126)***	(0.129)***	(0.130)***	(0.146)***	(0.131)***
R^2	0.03	0.03	0.03	0.03	0.06	0.06	0.06
N	3,584	3,584	3,584	3,584	3,584	3,584	3,584

Note: Sector-State fixed effects regressions with robust standard errors in parenthesis, clustered at the sector-state pair. EL, NG, and OD correspond to the domestic prices of electricity (average of tariffs for medium and large firms), natural gas, and oil derivatives respectively, deflated by the CPI. The operator Δ corresponds to the percent change. ULC denotes unit labor costs, measured at the industry level, REER denotes the cpi-weighted real effective exchange rate, WTI denotes the price of West Texas Intermediate oil prices, measured in nominal or in constant U.S. dollars, U.S. IP denotes the United States industrial production index, and U.S. r denotes the ex-post real interest rates measured as the difference between the yield on BAA Moody's-rated corporate bonds (all industries) and core inflation. * $p<0.1$; ** $p<0.05$; *** $p<0.01$.
Source: Instituto Nacional de Estadística y Geografia (INEGI) de Mexico, Federal Reserve Board of Governors, Bloomberg, Secretaria de Energia de Mexico, Haver analytics, and staff's calculations.

Table 3. Estimates of Elasticities When Energy Inputs Enter Separately

Dependent variable: Δy_{ijt} Sample: 1996-2012, annual	(1)	(2)	(3)	(4)
Δy_{ijt-1}	0.035 (0.037)	0.033 (0.038)	0.009 (0.041)	0.034 (0.038)
$\boldsymbol{\Delta EL_{t-1}}$	**-0.174 (0.028)*** **			
$\boldsymbol{\Delta NG_{t-1}}$		**-0.024 (0.008)*** **		
$\boldsymbol{\Delta OD_{t-1}}$			**0.038 (0.022)* **	
$\boldsymbol{\Delta LPG_{t-1}}$				**-0.091 (0.022)*** **
Δulc_{it-1}	-0.232 (0.030)***	-0.277 (0.032)***	-0.192 (0.050)***	-0.229 (0.031)***
$\Delta REER_{t-1}$	-0.032 (1.864)*	-0.088 (2.091)***	-0.065 (4.126)	-0.116 (2.329)***
$\Delta WTI\ (nominal)_{t-1}$	-0.003 (0.980)	-0.033 (1.099)***	-0.068 (2.028)***	-0.028 (1.143)**
$\Delta U.S.IP_{t-1}$	0.316 (5.638)***	0.315 (5.571)***	0.300 (7.121)***	0.329 (5.558)***
$\Delta U.S.r_{t-1}$	-0.610 (0.239)**	-0.586 (0.238)**	-0.635 (0.255)**	-0.919 (0.261)***
Constant	1.543 (0.114)***	1.292 (0.127)***	1.108 (0.090)***	1.390 (0.115)***
R^2	0.08	0.07	0.03	0.07
N	4,352	4,352	3,584	4,352

Note: Sector-State fixed effects regressions with robust standard errors in parenthesis, clustered at the sector-state pair. EL, NG, OD, and LNG correspond to the domestic prices of electricity (average of tariffs for medium and large firms), natural gas, oil derivatives, and liquefied natural gas respectively, deflated by the CPI. The operator Δ corresponds to the percent change. ULC denotes unit labor costs, measured at the industry level, REER denotes the cpi-weighted real effective exchange rate, WTI denotes the price of West Texas Intermediate oil prices, measured in nominal U.S. dollars, U.S. IP denotes the United States industrial production index, and U.S. r denotes the ex-post real interest rates measured as the difference between the yield on BAA Moody's-rated corporate bonds (all industries) and core inflation. Sample period is 1996–2012 except for when oil derivatives are included in the regression where it goes from 1998–2012 because of data availability issues. * p<0.1; ** p<0.05; *** p<0.01.

Source: Instituto Nacional de Estadística y Geografia (INEGI) de Mexico, Federal Reserve Board of Governors, Bloomberg, Secretaria de Energia de Mexico, Haver analytics, and staff's calculations.

Table 4. Differential Effects Across Subsectors

Dependent variable: Δy_{ijt}, Sample period: 1996–2012	(1)	(2)	(3)
Δy_{ijt-1}	0.008	0.011	0.011
	(0.040)	(0.040)	(0.040)
ΔEL_{t-1}	**-0.282**	**-0.529**	**-0.514**
	(0.041)* **	**(0.075)*** **	**(0.080)*** **
ΔNG_{t-1}	**-0.116**	**-0.036**	**-0.044**
	(0.031)* **	**(0.014)** **	**(0.031)**
ΔOD_{t-1}	**0.020**	**0.022**	**0.022**
	(0.029)	**(0.029)**	**(0.029)**
Δulc_{it-1}	-0.077	-0.114	-0.130
	(0.052)	(0.055)**	(0.057)**
$\Delta REER_{t-1}$	-0.312	-0.296	-0.290
	(5.452)***	(5.524)***	(5.515)***
$\Delta WTI\ (nominal)_{t-1}$	0.072	0.067	0.066
	(2.460)***	(2.460)***	(2.473)***
$\Delta U.S.IP_{t-1}$	0.487	0.466	0.458
	(7.502)***	(7.502)***	(7.422)***
$\Delta U.S.r_{t-1}$	-0.672	-0.666	-0.664
	(0.255)***	(0.255)***	(0.256)***
ΔNG_{t-1}*Food, beverages, and tobacco	**0.124**		**0.029**
	(0.029)* **		**(0.031)**
ΔNG_{t-1}*Textiles	**0.059**		**0.032**
	(0.034)*		**(0.047)**
ΔNG_{t-1}*Wood and wood products	**0.065**		**-0.000**
	(0.035)*		**(0.041)**
ΔNG_{t-1}*Paper and paper products	**0.084**		**0.026**
	(0.031)* **		**(0.034)**
ΔNG_{t-1}*Chemicals and oil derivatives	**0.065**		**-0.059**
	(0.033)*		**(0.033)***
ΔNG_{t-1}*Minerals, non-metals	**0.128**		**0.061**
	(0.032)* **		**(0.036)***
ΔNG_{t-1}*Other	**0.101**		**-0.023**
	(0.041) **		**(0.042)**
ΔEL_{t-1} *Food, beverages, and tobacco		**0.370**	**0.317**
		(0.075)* **	**(0.084)*** **
ΔEL_{t-1} * Textiles		**0.155**	**0.097**
		(0.096)	**(0.136)**
ΔEL_{t-1}*Wood and wood products		**0.225**	**0.228**
		(0.086)* **	**(0.098)** **
ΔEL_{t-1}*Paper and paper products		**0.249**	**0.202**
		(0.080)* **	**(0.087)** **
ΔEL_{t-1}*Chemicals and oil derivatives		**0.302**	**0.421**
		(0.091)* **	**(0.098)*** **
ΔEL_{t-1}*Minerals, non-metals		**0.345**	**0.230**
		(0.084)* **	**(0.095)** **
ΔEL_{t-1}*Other		**0.366**	**0.415**
		(0.125)* **	**(0.151)*** **
Constant	0.956	0.957	0.958
	(0.130)***	(0.130)***	(0.130)***
R^2	0.07	0.07	0.07
N	3,584	3,584	3,584

Note: Sector-State fixed effects regressions with robust standard errors in parenthesis, clustered at the sector-state pair. EL, NG, and OD correspond to the domestic prices of electricity (average of tariffs for medium and large firms), natural gas, and oil derivatives respectively, deflated by the CPI. The operator Δ corresponds to the percent change. ULC denotes unit labor costs, measured at the industry level, REER denotes the cpi-weighted real effective exchange rate, WTI denotes the price of West Texas Intermediate oil prices, measured in nominal U.S. dollars, U.S. IP denotes the United States industrial production index, and U.S. r denotes the ex-post real interest rates measured as the difference between the yield on BAA Moody's-rated corporate bonds (all industries) and core inflation. * $p<0.1$; ** $p<0.05$; *** $p<0.01$.
Source: Instituto Nacional de Estadística y Geografia (INEGI) de Mexico, Federal Reserve Board of Governors, Bloomberg, Secretaria de Energia de Mexico, Haver analytics, and staff's calculations.

Appendix I. Panel VAR model

Spillovers are assessed using Panel VAR's with output, real interest rates, U.S. industrial production, unit labor costs, and electricity prices. Manufacturing output ($y_{i,j,t}$) is measured at each state (*i*), subsector (*j*), and year (*t*), real interest rates (r_t) correspond to the ex-post real yield on Moody's U.S. corporate bonds, U.S. industrial production ($USIP_t$), unit labor costs measured at the subsector ($ULC_{j,t}$) and electricity prices ($Elec_t$). Identification is achieved through Choleski ordering, with the baseline specification assuming the following order, including fixed effects at the state-subsector level:

$$J\begin{pmatrix}\Delta r_t\\ \Delta USIP_t\\ \Delta ULC_{j,t}\\ \Delta y_{i,j,t}\\ \Delta Elec_t\end{pmatrix} = A * \begin{pmatrix}\Delta r_{t-1}\\ \Delta USIP_{t-1}\\ \Delta ULC_{j,t-1}\\ \Delta y_{i,j,t-1}\\ \Delta Elec_{t-1}\end{pmatrix} + c_{i,j} + u_{i,j,t}$$

$$t = 1, \dots, T \; i = 1, \dots, I \;\; j = 1, \dots, J \;\; u_{i,j,t} \sim N(0, \Sigma)$$

where J is an upper triangular matrix, $c_{i,j}$ are state-subsector fixed effects, $u_{i,j,t}$ is the error term, Σ is a constant covariance matrix and *A* is a 5x5 coefficient matrix.

We also estimate a variant of the above system, allowing spillovers within subsectors of the manufacturing industry and non-manufacturing sectors. To this end, we estimate the following variation of the previous equation:

$$J\begin{pmatrix}\Delta r_t\\ \Delta USIP_t\\ \Delta ULC_t\\ \Delta \mathbf{Y_{i,t}}\\ \Delta Elec_t\end{pmatrix} = A * \begin{pmatrix}\Delta r_{t-1}\\ \Delta USIP_{t-1}\\ \Delta ULC_{t-1}\\ \Delta \mathbf{Y_{i,t-1}}\\ \Delta Elec_{t-1}\end{pmatrix} + c_i + u_{i,t}$$

where $\mathbf{Y_{i,t}}$ is a 13x1 vector containing the manufacturing output for each subsector, as well as the output growth in non-manufacturing sectors of the economy, taken from the national accounts. ULC_t are the total manufacturing unit labor costs at the national level, and c_i are state fixed effects. Impulse response functions without spillovers are calculated by restricting the coefficients of output in each sector to the output in other sectors to zero.

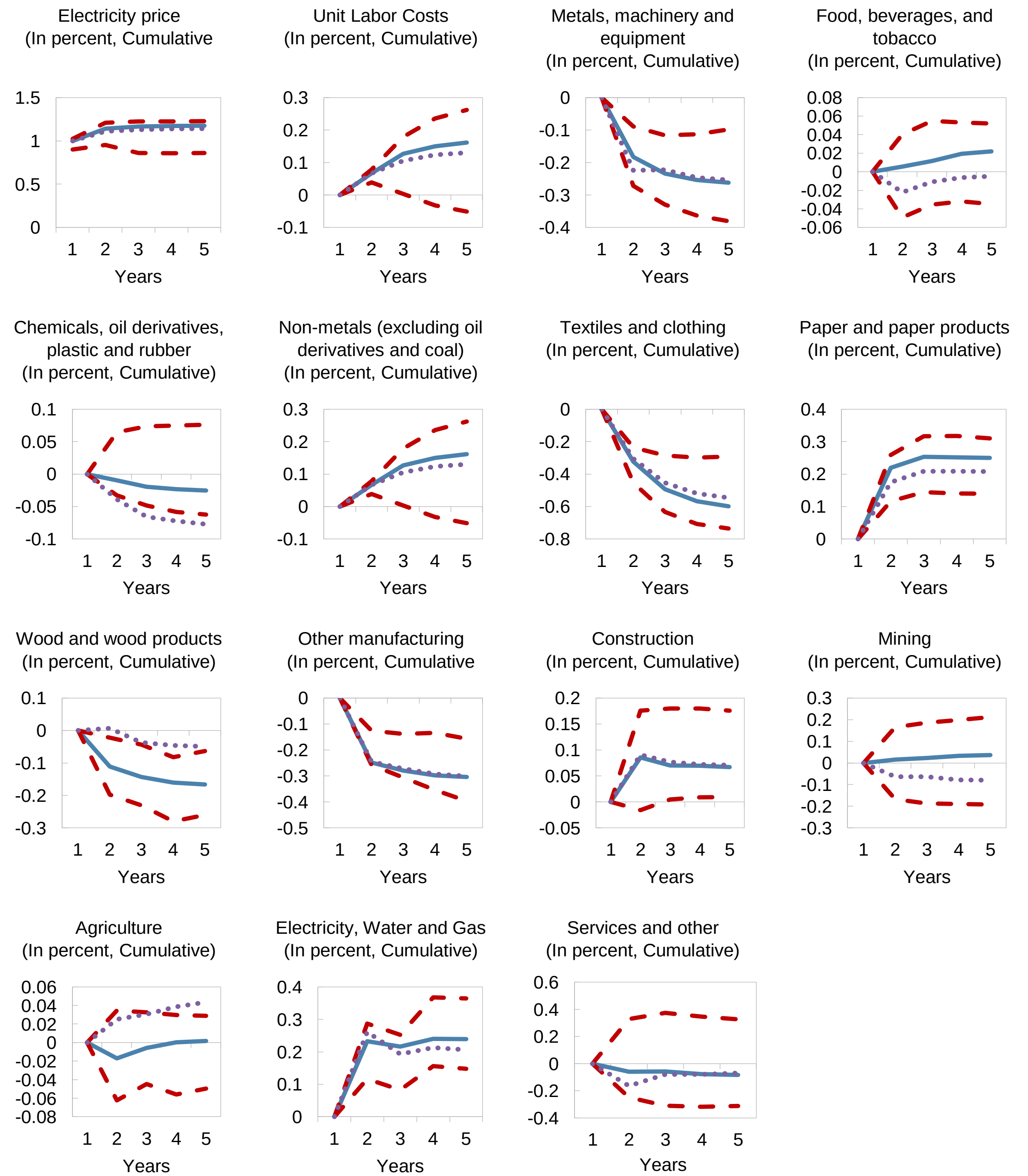
Regional spillovers are estimated similarly. Model 4 studies the effect of potential spillovers between regions by estimating:

$$J\begin{pmatrix}\Delta r_t\\ \Delta USIP_t\\ \Delta ULC_t\\ \Delta \mathbf{Y_{j,t}}\\ \Delta Elec_t\end{pmatrix} = A * \begin{pmatrix}\Delta r_{t-1}\\ \Delta USIP_{t-1}\\ \Delta\ ULC_{t-1}\\ \Delta \mathbf{Y_{j,t-1}}\\ \Delta Elec_{t-1}\end{pmatrix} + c_j + u_{j,t}$$

where $\mathbf{Y_{j,t}}$ is a 5x1 vector containing the manufacturing output from each economic region of Mexico, and fixed effects are included at the subsector level.

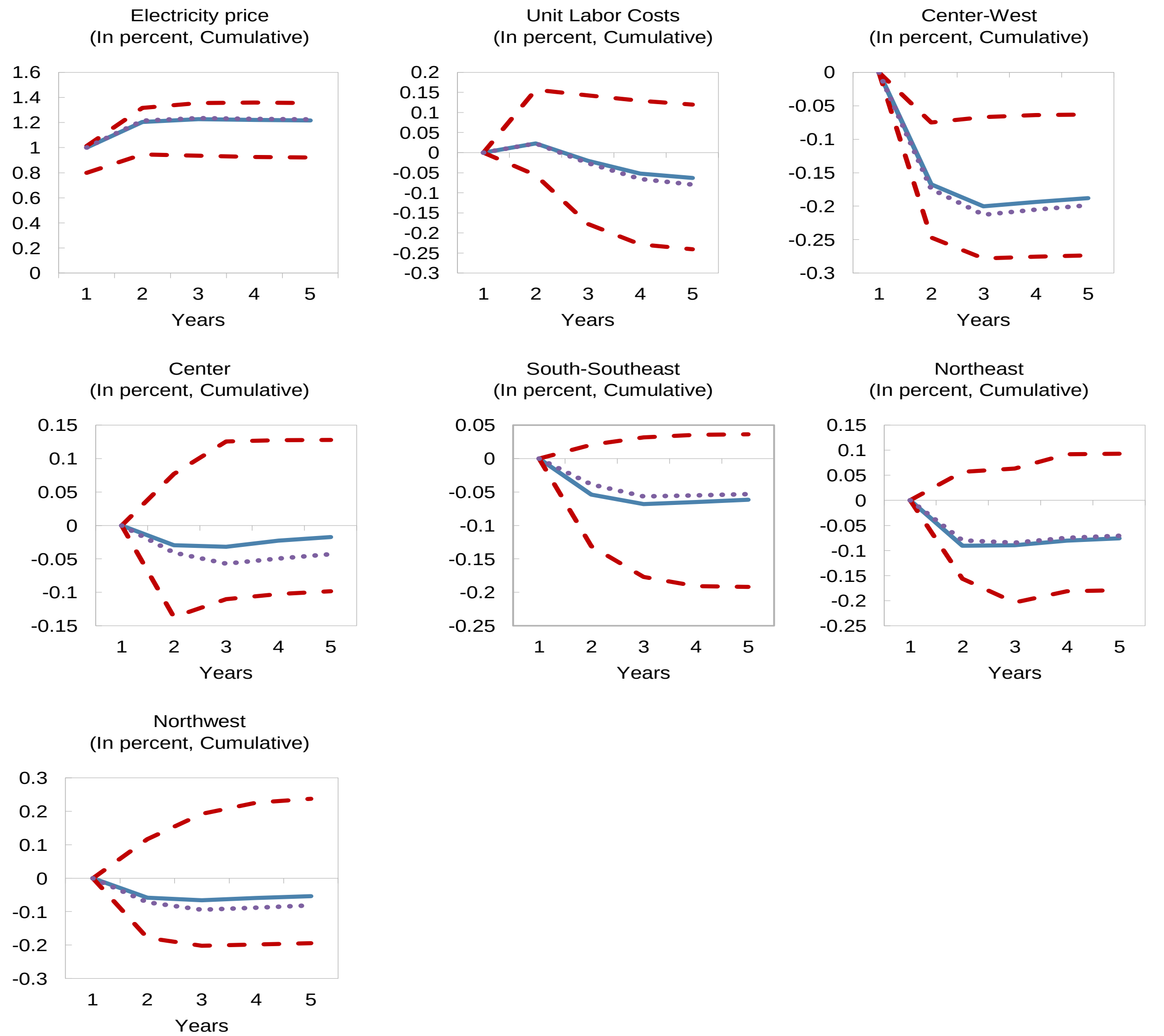
In all models, the real interest rate and U.S. industrial production are assumed to be exogenous from other variables. Impulse response functions to a 1 percent shock to electricity prices are reported along with bootstrapped confidence intervals.

Appendix Figure 1. Impulse response functions to a rise in electricity prices with subsector spillovers



Note: Impulse response functions are calculated for a period of 5 years with a shock of 1% to electricity prices for both the model without spillovers (solid blue) and with spillovers (dotted purple). 90% confidence interval bands (dashed red) are based on parametric bootstrapped standard errors on the model without spillovers. All variables are expressed as yearly differences.

Appendix Figure 2. Impulse Response Functions to a Rise in Electricity Prices with Regional Spillovers



Note: Manufacturing output for the five economic regions of Mexico. Impulse response functions are calculated for a period of 5 years with a shock of 1% to electricity prices for both the model without spillovers (solid blue) and with spillovers (dotted purple). 90% confidence interval bands (dashed red) are based on parametric bootstrapped standard errors in the model without spillovers. All variables are expressed as yearly differences. The regions are defined as follows: Center (Distrito Federal, Hidalgo, Estado de Mexico, Morelos, Puebla, Tlaxcala), Center-West (Aguascalientes, Colima, Guanajuato, Jalisco, Michoacan, Nayarit, Queretaro, San Luis Potosi, Zacatecas), Northeast (Coahuila, Chihuahua, Durango, Nuevo Leon, Tamaulipas), South-Southeast (Campeche, Chiapas, Guerrero, Oaxaca, Quinatana Roo, Tabasco, Veracruz, Yucatan), and Northwest (Baja California, Baja California Sur, Sinaloa, Sonora). All variables are expressed as yearly differences.

CAPITAL FLOW VOLATILITY AND INVESTOR BEHAVIOUR IN MEXICO[1]

Summary

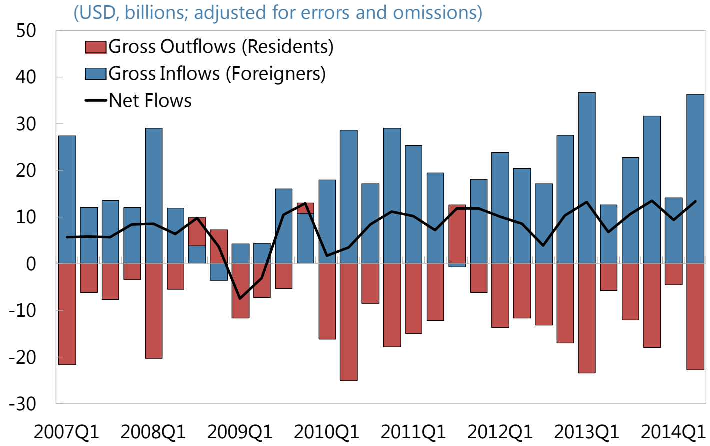
The size and volatility of gross capital inflows (particularly portfolio inflows) to Mexico have increased significantly in recent years. This paper investigates how the volatility of gross capital flows could be affected by the behavior of foreign investors, especially during the periods of market stress, and whether domestic investors behaved differently from foreign investors. Our study of some 1000 foreign and domestic mutual funds in Mexico found strong evidence that foreign mutual fund investors exhibited potentially destabilizing trading behaviors that could contribute to market volatility. The evidence on domestic mutual funds' destabilizing behavior was weaker. Our study of the Mexican sovereign bond markets also shows that foreign participation tended to amplify the impact of global financial shocks on these markets, notably in periods of market stress. Domestic institutional investors played some mitigating role, but the evidence is mixed and depends on the nature of the external shocks. These findings underline the importance of country insurance against global shocks and the potential role that a deep and diverse domestic investor base could play to mitigate such shocks.

A. Introduction

1. Gross capital inflows (particularly portfolio inflows) to Mexico have increased significantly in recent years (chart). Mexico has particularly strong links to the United States, its largest trading partner and the main source of portfolio and foreign direct investment. Mexico's reputation as a prudently managed economy, with strong fundamentals, an open capital account, and relatively deep and liquid financial markets, has attracted significant portfolio inflows recently. In 2010, Mexico also became the first Latin American country to be included in the Citigroup's World Government Bond Index (WGBI), attracting new groups of foreign

Net Capital Flows

(USD, billions; adjusted for errors and omissions)



Sources: Haver Analytics.

[1] Prepared by Jianping Zhou, Han Fei, and Jasmine Xiao. The authors would like to thank Dora Iakova, Hibiki Ichiue, Herman Kamil, Robert Rennhack, Alejandro Werner, and seminar participants at the IMF, Secretaría de Hacienda y Crédito Público, and Banco de México for comments and discussions.

investors. The share of non-resident holdings of domestic sovereign debt has reached 36 percent in April 2014, among the highest in emerging markets.

2. **Portfolio capital inflows have also become more volatile**. As observed in major emerging economies, capital inflows to Mexico surged prior to the global financial crisis (GFC), contracted sharply during the crisis (2008–09), rebounded to an higher level in 2010, fell again during European crisis in 2011, surged again in 2012 and contracted sharply after the U.S. Federal Reserve made its announcement about tapering in May 2013. Excessive volatility in capital flows could amplify economic cycles, increase financial system vulnerabilities, and aggravate overall macroeconomic instability. While our paper does not assess causation, past episodes of sharp contraction in portfolio inflows suggest that global factors could lead to a rapid rebalancing of investor portfolios away from assets in Mexico (as well as in other key emerging market countries) and Mexico remains vulnerable to the risks that the process of normalization of U.S. monetary policy may not proceed smoothly and geopolitical events could deteriorate further.[2]

3. **Domestic investors' flows have become more important**. Mexico has a steadily expanding and diverse domestic investor base. Pension, insurance, and mutual funds now account for about half of the financial system (more than 40 percent of GDP). For example, over the last 10 years pension funds' assets have increased by about 18 percent annually, and gradual changes in government regulations have allowed them to diversify their portfolios and invest abroad.[3] While foreign investors rapidly increased their holdings of Mexican government debt in all currencies, domestic investors have increased their holdings at a much slower pace, and instead built up their holdings of foreign assets. When portfolio inflows stopped during the GFC, domestic residents retrenched, selling their foreign assets and bringing the money home.

4. **Our study investigates how the volatility of gross capital flows in Mexico could be affected by the behavior of foreign and domestic investors, especially during the periods of market stress.** Specifically, we try to reconcile the aggregated macro data with the high frequency market and fund-level data. In doing so, we aim to address the following questions:

- Have foreign investors behaved differently from domestic investors, particularly during the periods of market stress?
- Have they been more destabilizing?

[2] For a discussion on U.S. monetary policy uncertainly, see "Fed chiefs debate monetary normalization while Yellen passes off financial stability", CITI Research, July 11, 2014.

[3] Reforms to the Mexican pension system have strengthened the demand for government securities. The transformation in 1997 of a pay-as-you-go system into an individual contributory pension system for private workers resulted in a surge of large pension funds. Later on in 2007, the pension system of public employees went through a similar reform which further increased assets managed by pension funds, hence stimulating additional demand for securities (see Sidaoui, José, Julio Santaella and Javier Pérez 2012).

- Do domestic investors have a mitigating role to play?

5. **Our study contributes to the literature and policy debate in two ways.** First, we discuss capital flow volatility from the perspective of the behavior of different classes of investors; and second, we conduct empirical investigation using three unique datasets on Mexico, which to the best of our knowledge have not been used previously for studying the role of foreign investors in Mexico. For example, our analysis of the mutual funds investing in Mexico relies on an extensive fund flows dataset for about 400 international mutual funds (including global, emerging market-dedicated, Latin America-dedicated, and Mexico-dedicated funds) and 540 Mexican mutual funds active in the local markets in Mexico at a monthly frequency, with the latest data observation as recent as in April 2014. This enables us to gain valuable insight into their behavior during volatile periods, such as around the Fed tapering announcement in May 2013.

6. **The rest of the paper is organized as follows**: Section B discusses recent extreme capital flow episodes in Mexico following the methodology developed by Forbes and Warnock (2012); in section C, we study the behavior of domestic and foreign mutual funds active in Mexico during these episodes to assess their contribution to capital flow volatility.[4] A time-series analysis in Section D investigates whether the participation of foreign investors in Mexico's sovereign bond market has amplified the impact of external shocks during these episodes, and whether domestic investors (banks, pension and insurance funds, mutual funds, and other investors) have played a mitigating role; Section E concludes with policy implications.

B. Recent Episodes of Extreme Capital Movements in Mexico

7. **Recent studies on capital flow volatility emphasized the importance of analyzing gross capital flows instead of net flows** (Forbes and Warnock, 2012; Milesi-Ferretti and Tille, 2010). The literature's earlier focus on net flows was largely based on the developments in the early and mid-1990s when net capital inflows roughly mirrored gross inflows, since the capital outflows of domestic investors tended to be small and changes in net inflows could thus be interpreted as being driven by changes in foreign flows. The new focus on gross flows in recent studies arises from the recognition that analyses based solely on net flows will overlook the significant changes in gross flows that have occurred recently—due to global financial integration and the development of a domestic investor base in many EM countries—and ignore important information contained in these flows, especially since foreign and domestic investors may well be motivated by different factors and respond differently to policies and shocks. In the case of Mexico, the size and volatility of gross flows have increased rapidly in recent years while net capital flows have been more stable, highlighting the importance of differentiating between gross inflows and gross outflows.

[4] An extension of this paper will estimate the impact of mutual funds' trading behaviors on price volatility.

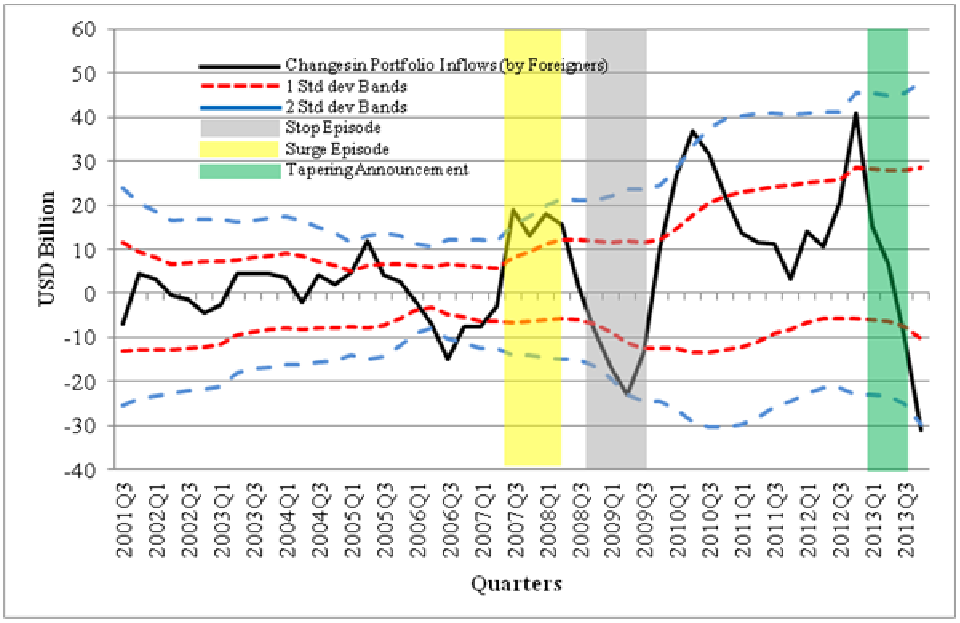
8. By focusing on gross capital inflows and outflows, we differentiate capital movements viewed as being initiated by foreigners from those initiated by domestic residents.[5] To do so, we follow the approach in Forbes and Warnock (2012) to identify the following four types of extreme portfolio capital flow movements in Mexico over the period 1995 through 2013 at a quarterly frequency. Thus, a "surge" event corresponds to a sharp increase in nonresidents' gross capital inflows, a sharp decrease in these gross inflows is referred to as a "stop" event; a sharp increase in residents' gross capital outflows is a "flight"; and a "retrenchment" event refers to a sharp decrease in residents' gross capital outflows.[6] This allows us to differentiate the types of capital flow volatility episodes driven by foreigners (surges and stops) from those driven by domestic investors (flights and retrenchments). The reason for this approach is that we are interested in exploring whether domestic residents have mitigated the impact of a capital flow surge by foreigners and the subsequent sudden stop during the periods of markets stress.

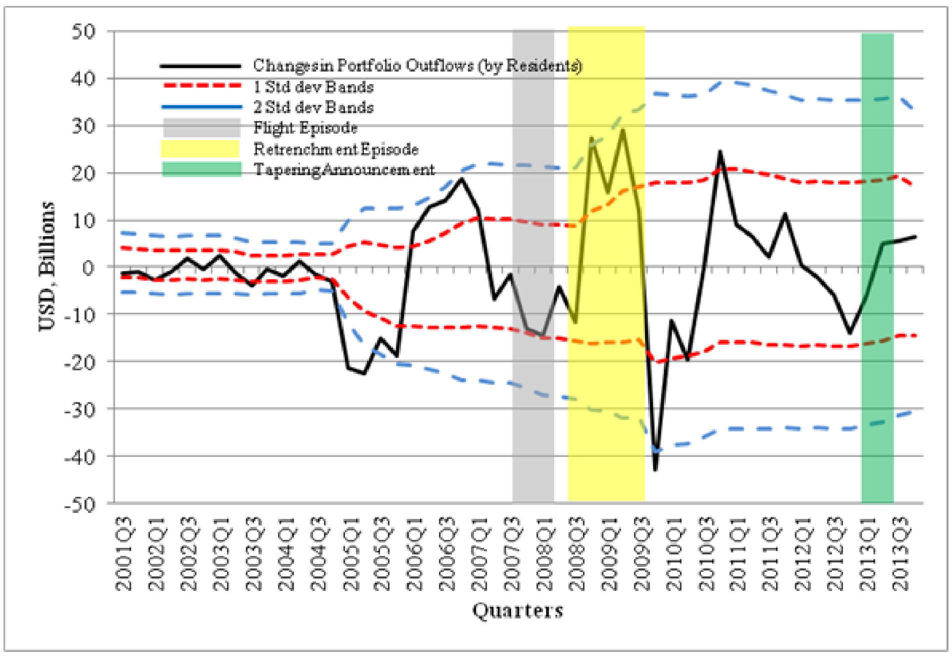
9. Figure 1 suggests that domestic residents did act differently from their foreign peers during the GFC and also during the Fed tapering incident in May 2013 though to a lesser extent. Prior to the Lehman incident, foreign portfolio inflows increased sharply (a surge) and they were largely offset by an increase in capital outflows by residents (a flight). During the height of the global financial crisis, gross portfolio inflows from foreigners fell sharply (a stop) as they sold Mexican assets, while residents sold their foreign assets and brought the money home (a retrenchment). During the tapering talk in May 2013, foreign portfolio investors reduced their holding of Mexican assets as sharply as they did during the GFC. What was different, however, is that the recent sharp decline was offset only partially by opposite actions taken by the domestic residents.

[5] We use data from the International Monetary Fund's International Financial Statistics, in which international capital flows are based on the residency criterion of the balance of payments, and cover transactions where one of the counterparties is a resident of the country (say Mexico) and the other a resident of the rest of the world. Capital outflows denote net purchases by domestic residents of financial instruments issued by non-residents, while capital inflows denote net purchases by foreign residents of domestic financial instruments. The difference between capital inflows and outflows (the financial account balance) corresponds to the current account balance (up to a statistical discrepancy).

[6] Forbes and Warnock (2012) defines extreme capital flow episodes using three criteria: (1) current year-over-year changes in four-quarter gross capital inflows or outflows is more than two standard deviations above or below the historic average during at least one quarter of the episode; (2) the episode lasts for all consecutive quarters for which the year-over-year change in annual gross capital flows is more than one standard deviation above or below the historical average; and (3) the length of the episode is greater than one quarter.

Figure 1. Mexico: Extreme Capital Flow Episodes





C. Behavior of Foreign and Domestic Mutual Funds in Mexico

In this section, we study the behavior of mutual funds active in Mexico during the periods of market stress, especially shortly after the Fed tapering announcement in May 2013. We explore whether foreign mutual fund investors are more inclined than domestic investors to sell as others are selling ('herding behavior'), and to buy when prices have risen ('positive-feedback trading behavior'), relying on two extensive fund flows datasets, one covers about 400 foreign mutual funds and another covers 540 Mexican mutual funds, at monthly frequency and with the latest data observation as recent as April 2014. By doing so, we hope provide one plausible explanation for the large portfolio outflows during the episodes of market stress, from the perspective of individual investor behaviors.

10. Herding in financial markets emerges when investors mimic other investors. Such behavior can potentially destabilize financial markets, aggravate shocks, and lead to mispricing or asset price bubbles. While herding can be the result of cognitive biases or of "heuristic"-based decision making, it can also be a result of several other factors. For instance, herding may emerge if there is asymmetric information sharing, which induces less-informed asset managers to follow their possibly better-informed peers instead of relying on their own assessments, and in this context, improving transparency may help reduce herding behavior (Kim and Wei, 2002; Bikhchandani, Hirshleifer, and Welch, 1992). Herding may also occur if asset managers are evaluated against each other (Scharfstein and Stein, 1990) or vis-à-vis similar benchmarks (Maug and Naik, 2011).

11. We use fund-level data in our analysis of herding and momentum trading behaviors. To this end, we estimate the flow from each fund to Mexico using the country allocation data set from the EPFR Global (see Box 2 for details). As of April 2014, there are a total of 375 foreign mutual funds actively investing in Mexico, among which 112 are bond funds, and 263 are equity funds. Our full sample is from January 2007 to April 2014, covering two "stress" episodes, namely the Global Financial Crisis and the tapering announcement in May 2013, during which Mexico experienced significant declines in gross portfolio inflows. In order to facilitate comparison between domestic and foreign mutual funds active in Mexico, we use a shorter sample period (January 2011 to April 2014) for the analysis on momentum trading, as data on domestic mutual funds is only available from January 2011.

12. We use two (related) measures to quantify co-movements in trading patterns for funds—foreign or domestic—investing in Mexico:

- A simple measure, defined by the proportion of all funds active in Mexico (in a particular month) that are net sellers. This gives intuitive and indicative evidence of whether "correlated" selling occurs at times of market stress.

- A commonly used herding index originally introduced by Lakonshiok, Shleifer, and Vishy (1992). This index assesses whether funds move in the same direction more often than one would expect if they traded independently and randomly, and is computed as follows:

$$HM_{mex,t} = |p_{mex,t} - p_t| - AF_{mex,t},$$

where $p_{mex,t}$ is the proportion of funds active in Mexico that are net buyers in month t, p_t is its expected value, and $AF_{mex,t}$ is an adjustment factor so that $HM_{mex,t}$ is zero when there is no herding. p_t is approximated by the share of funds that are net buyers across all emerging markets,[7] and is allowed to be time-varying to control for common trends across countries, such as swings in aggregate inflows to emerging markets due to market-wide developments. The adjustment factor is equal to the expected value of the first term under the null hypothesis that there is no herding[8]

13. Both measures point to the evidence on "herding" behavior among the mutual funds, notably the foreign mutual funds (Figures 2 and 3). More specifically, we found:

- Foreign mutual funds (both bond and equity) exhibited a strong tendency to sell Mexican assets during the periods of heightened global uncertainty. For instance, after Lehman Brothers collapsed in September 2008, around 75 and 95 percent of equity and bond funds active in Mexico were net sellers of Mexican assets, respectively.

- Foreign mutual fund investors are more inclined to exhibit "herding" behaviors than domestic investors. During the tapering announcement in 2013, around 50 percent of domestic mutual funds were selling Mexican assets, while at the same time the number of net sellers among foreign mutual funds rose to above 70 percent. This observation is consistent with the result based on the herding index (Figure 3), which shows herding among foreign mutual funds (bond and equity) increased significantly around the tapering announcement in May 2013, in comparison to the period beforehand.

[7] Our sample of emerging markets include: Argentina, Bangladesh, Brazil, Bulgaria, Chile, China, Colombia, Croatia, Czech Republic, Egypt, Hungary, India, Indonesia, Israel, Jordan, Korea, Latvia, Lebanon, Lithuania, Malaysia, Mexico, Morocco, Nigeria, Pakistan, Peru, Philippines, Poland, Romania, Russia, Serbia, South Africa, Sri Lanka, Taiwan Province of China, Thailand, Turkey, Ukraine, Uruguay, and Vietnam.

[8] This is needed since the distribution of the first term is not centered on zero.

Figure 2. Evidence of Herding
(Net sellers as a percent of total funds)

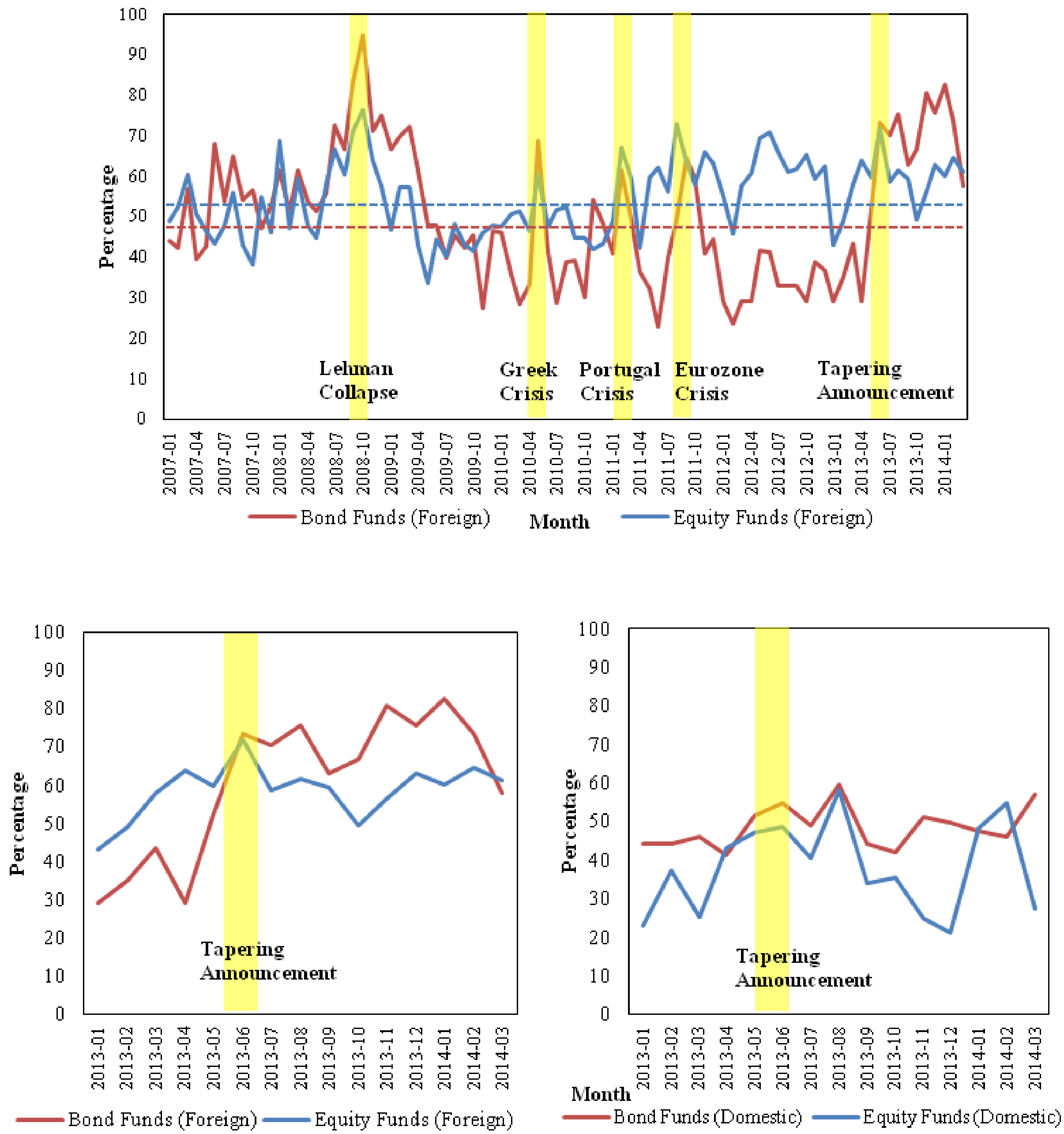
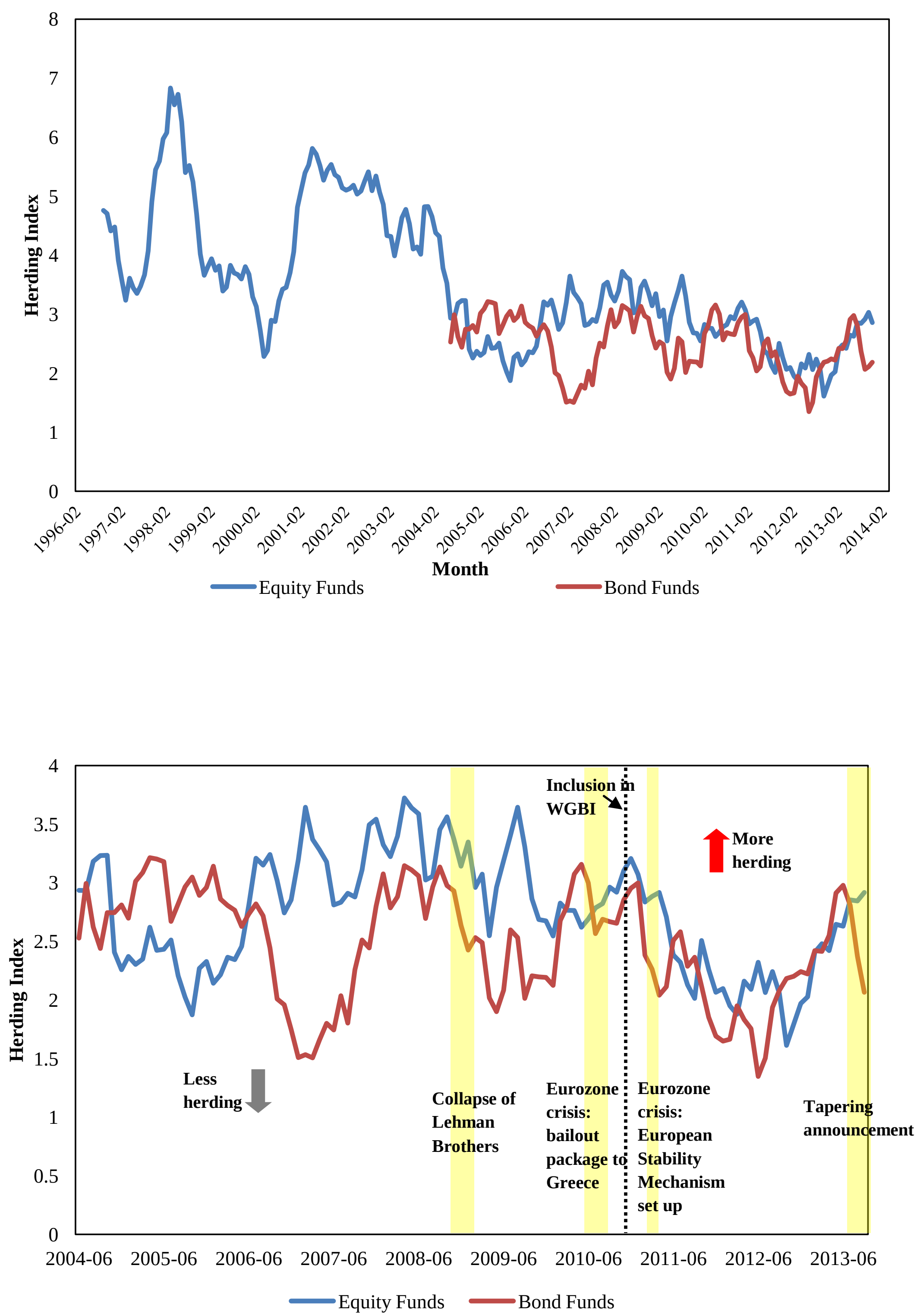


Figure 3. Evidence of Herding
(based on the herding index)



14. Next, we examine the evidence of positive-feedback trading behavior among the mutual funds, differentiating foreign funds from domestic funds. Since foreign investors exhibit a stronger tendency to sell assets simultaneously at times of market stress, we also examine whether foreign investors show a stronger tendency to acquire (sell) more of an asset during periods of rising (falling) returns than domestic investors. We focus particularly on comparing the behaviors of bond and equity funds during stress and non-stress periods.

15. To do so we estimate the following equation that links the change in a fund's current asset position to the past return,[9] for a panel dataset consisting of 546 domestic mutual funds and 375 foreign mutual funds that includes global funds, EM dedicated funds, Latin America regional funds and funds dedicated Mexico only.

$$Flow_{i,t} = \alpha_i + \beta_1 Return_{t-1} + \beta_3 Stress_t * Return_{t-1} + \beta_2 Stress_t + \varepsilon_{i,t},$$

where $Flow_{i,t}$ is the flow of fund i to Mexico in month t. $Return_{t-1}$ is either the (peso-denominated) return on the Mexico's 3-month government bonds (for bond funds) or the return in the Mexico's stock market (for equity funds).[10] We take a one-month lag to mitigate concerns about endogeneity. $Stress_t$ is a dummy variable that is equal to one for the periods of Global Financial Crisis and tapering announcement, and zero otherwise.[11] The model also includes fund fixed effects α_i.

16. We found strong evidence of "positive feedback trading" behavior among foreign bond funds during the periods of market stress (Tables 1a and 1b). The evidence that domestic bond funds exhibit "positive feedback trading" behaviors is not significant. For the foreign bond funds, the "positive feedback trading" behavior tended to be stronger during the episodes of market stress than during normal times. There is evidence that domestic equity funds appear to follow a "negative-feedback" trading strategy by which they would buy during periods of falling returns and sell during periods of rising returns. On the other hand, foreign equity funds do not exhibit statistically significant "positive feedback trading" behaviors during normal times, but do so during crisis times. The coefficient on the stress dummy is negative as expected, as it captures the overall tendency of funds to reduce exposures to Mexico at times of market stress. To check the robustness of our results, we used different sample periods (especially for the foreign funds) and U.S. dollar–denominated returns for the estimations (Table 2a and 2b).

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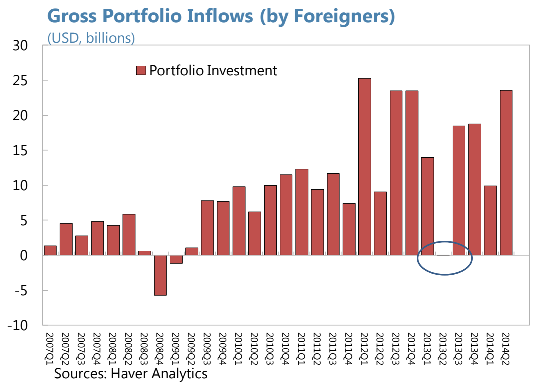
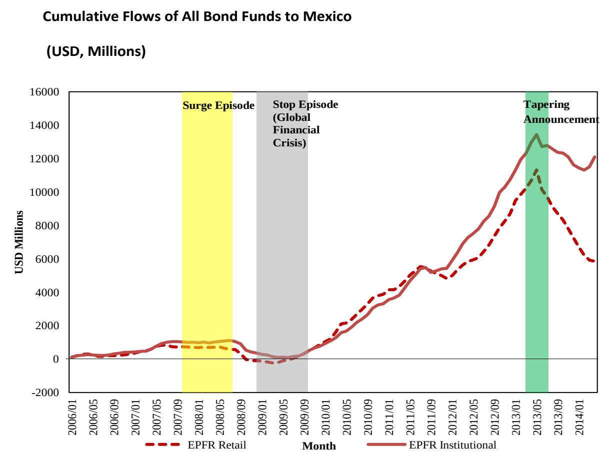
[9] We followed the approach adopted in Hsieh et al (2011) and IMF (2014).

[10] For robustness checks, we used (i) the return on the Mexico's 10-year government bonds (instead of 3-month government bonds), and (ii) the dollar-denominated return on the Mexico's government bonds.

[11] We use these two episodes as "stress" episodes, because: (i) the height of the Global Financial Crisis (2008Q3 – 2009Q3) qualifies as an episode of sudden stop, according to the Forbes and Warnock (2012) methodology; and (ii) during the tapering announcement in May 2013, portfolio inflows to Mexico fell, drastically and significantly, two standard deviations below its five year rolling mean.

17. These micro-level findings provide one plausible explanation for what we observe from macro-level data—the large portfolio outflows during the episodes of market stress—from the perspective of individual investor behaviors. For example, between Q2 and Q1 2013, the capital inflows (by non-residents) fell by US$24.5 billion, of which US$14 billion was due to a sudden stop in portfolio inflows. Much of this large decline seems to reflect a sharp reduction of foreign mutual funds' investment in Mexico, especially by the small retail funds.

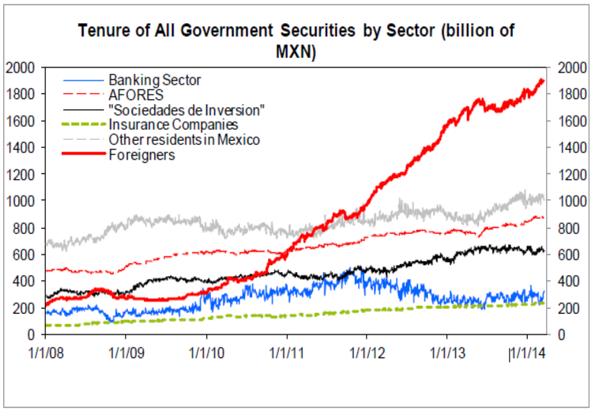


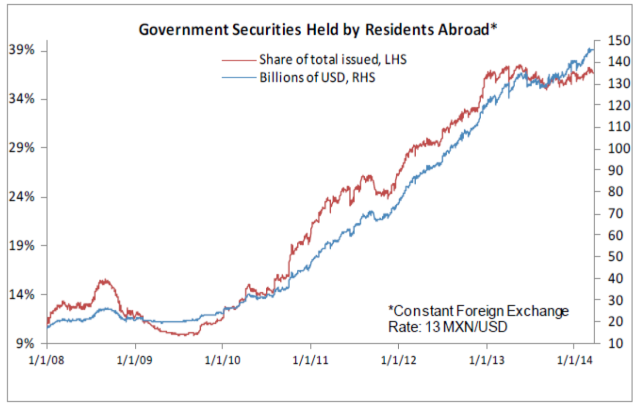


D. Does Foreign Participation Amplify External Shock? A Time-Series Analysis of Mexican Sovereign Bond Market

In this section, we estimate two empirical models, an OLS model and a GARCH model, to investigate whether higher foreign participation has amplified the impact of global financial shocks on the Mexican sovereign debt market and whether domestic investors played a mitigating role. The empirical investigation relies on an informative database of aggregate bond holdings by foreigners and residents (banking sector, insurance funds, pension funds, mutual funds, other investors) at the daily frequency.

18. The share of non-resident holdings of domestic sovereign debt in Mexico has risen rapidly, especially relative to residents' holdings (charts below). Traditionally, Mexico has been a popular market for the U.S. investors, who represent a large share of the total foreign investors in Mexico. Since 2007, investors from Europe and Japan have also boosted their holdings of the Mexican assets. Moreover, the inclusion of Mexico in the Citibank's World Government Bond Index (WGIB) in October 2010 paved the way for more participation by foreign investors. Moreover, it appears that many foreign investors have been able to hedge their currency risk exposures as the Mexican peso is the most traded EM currencies globally.



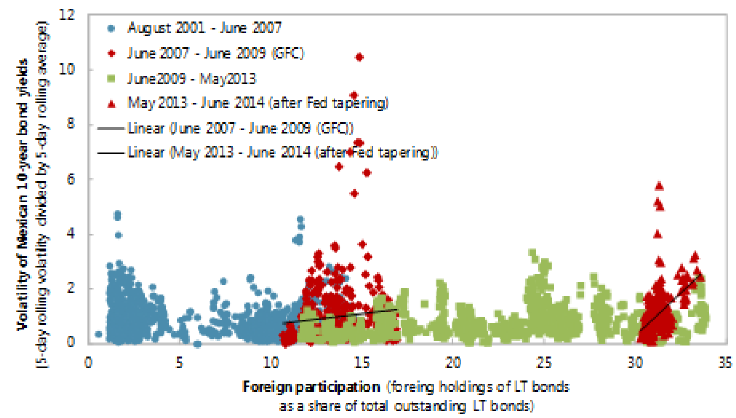


19. Whether foreign participation increases market volatility is subject to ongoing debate. Foreign participation, to the extent that it increases market liquidity and exerts pressure for strong corporate governance and institutional reform, can be a stabilizing force in the long run (Prasad and Rajan, 2008). However, sudden withdrawals by foreign investors from domestic bond markets, as happened in EMs in 2008/2009 and more recently after the tapering announcement, could introduce greater bond yield volatility. Foreign investors in the EMs could be more sensitive to global and EM shocks than EM domestic investors, due to home bias and asset allocation decisions that could be influenced by information asymmetries and hedging costs of currency risks. Empirical evidence on the impact of foreign participation on market volatility is sparse and mixed. Several recent IMF working papers, based on cross-country evidence, found that while high foreign participation in the local markets helped reduce borrowing costs it was associated with higher yield volatilities (Ebeke and Lu, 2014; Andritzky, 2012).[12] However, another IMF paper found that greater foreign participation does not necessarily result in increased volatility in bond yields in EMs and it could dampen volatility in some cases (Peiris, 2010).

[12] These papers have not advocated for capital control measures as their desirability and effectiveness are subject to debate, but they supported building up foreign exchange reserve buffers and developing a deep domestic investor base.

20. In the case of Mexico, the effect of foreign holdings of sovereign bonds on their yield volatility is not evident upon first glance. The chart on the right plots the volatility of Mexican 10-year sovereign bond yields against the level of foreign participation using data at daily frequency. It shows no clear correlation between the two for the whole sample period of 2000–14. However, for the periods of market stress (for example, during the GFC and the Fed's tapering announcement in May 2013), higher foreign participation seems to be associated with higher yield volatility. Thus, in our empirical analysis, we divided our sample period into a stress period and a non-stress period. Moreover, the chart reveals that Mexican 10-year sovereign bond yields exhibit the volatility clustering property, i.e., large changes in yields tend to be followed by large changes in volatility during the stress periods. Such a property has often been observed among time series of financial asset returns and linked to the behavior of market participants (Cont, 2005). We therefore also used GARCH models to address the presence of volatility clustering.

The Volatility of Mexican 10-Year Bond Yields and Foreign Participation



21. We estimate two time series models, an OLS model and a GARCH model, to investigate whether higher foreign participation has amplified the impact of global financial shocks on the local debt market and whether domestic investors acted differently. The empirical work focuses on the volatility of Mexican long-term (LT) local-currency sovereign bond yields. The estimation distinguishes normal time with low market volatility from the periods of market stress. The details of model specifications are discussed in Box 1. High frequency samples (at both weekly and daily frequencies) covering 2000–14 are constructed to conduct the estimations. Variables included in the OLS regressions are:

- **Volatility of the Mexican 10-year local-currency sovereign bond yields (dependent variable)**. For robustness, two measures of the yield volatility are used in the weekly and daily OLS regressions, respectively: (i) Within-week volatility, measured by the standard deviation of daily yields within each week normalized by the weekly mean; and (ii) 5-day rolling volatility, measured by the standard deviation of a 5-day rolling window of daily yields, normalized by the mean.

- **Foreign and domestic participation**, defined as the daily holdings of Mexican LT local-currency sovereign bonds by (i) foreign investors; and (ii) five different types of domestic investors (pension funds, insurance companies, mutual funds, banks, and other domestic investors) as shares of the total values of outstanding LT sovereign bonds.

- **Global financial shocks**, measured by (i) the VIX to capture global uncertainty; and (ii) the volatility in U.S. 10-year Treasury yields to capture the U.S. monetary policy shocks.

- **Domestic variables**: official international reserves (weekly, excluding gold), peso/US dollar exchange rate (daily), and interbank interest rate (daily).[13]

- **Variables included in the (daily) multivariate GARCH** models are the changes in the Mexican 10-year local-currency sovereign bond yields, the changes in the Mexican stock market returns (dependent variables), and the explanatory variables included in the daily OLS regressions.

22. The empirical results of the OLS regressions and multivariate GARCH models are presented in Tables 3a, 3b, 4a, and 4b. Several interesting results emerge:

- **First, foreign participation tends to amplify the impact of global financial shocks on the volatility of Mexican sovereign bond yields, notably during the periods of market stress**. Results from both the OLS regressions and the multivariate GARCH models are consistent and robust across all specifications. This implies that the foreign participation in the local-currency bond market can make the market more susceptible to adverse shifts in the market sentiment caused by global financial shocks. From finance theory, due to information asymmetry or currency risks, local-currency assets tend to have larger risks for foreign investors than for domestic investors when global risk aversion rises or global liquidity tightens. As a result, foreign investors' holdings of local-currency assets could be more sensitive to global financial conditions than local investors' holdings, generating "extra" volatility in local markets. The results of the GARCH regressions show that higher participation by foreign investors in the Mbono market heightens the sensivity of the volatility of the 10-year Mbono yield, without necessarily affecting the level of the Mbono yield, to a shock to the VIX. At the same time, increased foreign participation does make both the level and volatility of the Mbono yield more sensitive shocks to the yield on 10-year US Treasuries. This discrepancy could reflect the fact that—over this sample period—surges in the VIX were often associated decline in the level of the yield on the 10-year US Treasuries, since this asset was viewed as the safe asset.

- **Second, domestic investors in the sovereign bond market played some mitigating role, but the empirical evidence was mixed, depending on the type of investors and the nature of the global shocks**. In particular, banks seem to amplify the impact of global financial shocks on domestic yield volatility during normal times across all specifications, but their role during stress periods seems to be unclear. In addition, the results based on the OLS regressions find that domestic pension funds and banks seem to dampen the impact of VIX shock during stress periods, but there is no significant and robust evidence that the insurance sector or the mutual funds play any mitigating or amplifying role during stress periods. Moreover, the mitigating role of the pension funds no longer holds if the shock is to the U.S. 10-year Treasury yields. These

[13] The 28 day TIIE interbank equilibrium rate is used as the interbank interest rate to capture domestic monetary policy. The first-order differences of the reserves and interest rates, as well as the first-order differences of log exchange rates are used in the regressions.

mixed results tend to suggest that domestic investors are not significantly different from each other, and their behaviors would depend on the nature of the global financial shocks.[14]

23. These results are robust to the choices of dependent and independent variables. For the dependent variable, another volatility measure using the exchange rates rather than the sovereign bond yields is also used in the OLS regressions, and the main (qualitative) result that foreign participation tends to amplify global financial shocks does not change. For the independent variables, we replace the shares of respective investors in the interaction terms by their first-order differences, and the main results still hold.

E. Concluding Remarks

24. The size and volatility of gross capital inflows (particularly portfolio inflows) to Mexico have increased in recent years. Mexico remains vulnerable to global financial shocks, given its globally integrated financial markets. A resurgence of investor uncertainty triggered by an earlier or sharper-than-expected rise in U.S. interest rates (for example due to an unexpected rise in inflation or a decompression of U.S. term premia) presents a distinct risk in the near term. As our analysis of the Fed tapering incident in May 2013 has shown, such a shock could lead to a significant portfolio capital outflows from Mexico, resulted in high volatility in bond prices. A protracted period of financial market volatility could affect the confidence of long-term investors and threaten the ongoing progress on the implementation of structural reforms.

25. This paper investigates the behaviors of foreign and domestic investors, especially during the periods of market stress. More specifically, relying on three approaches using both macro- and micro-level data, our empirical investigations suggest that foreign and domestic investors do seem to behave differently. We found that foreign mutual fund investors exhibited potentially destabilizing trading behaviors that could contribute to market volatility. For examples, they tended to sell as others are selling ('herding behavior') and follow a "positive-feedback trading" strategy (i.e. buy high and sell low). We did not find significant evidence indicating that domestic mutual funds behaved similarly. Moreover, our study of the Mexican sovereign bond markets suggests that foreign participation tended to amplify the impact of global financial shocks, notably in periods of market stress. Domestic institutional investors played some mitigating role, but the evidence is mixed and depends on the nature of the external shocks.

26. These results imply that policy credibility will continue to be key to maintain market confidence at times of stress. Mexico has a strong policy framework,[15] with sound public finances, low and stable inflation, a sustainable external sector position, and a healthy banking system. It also

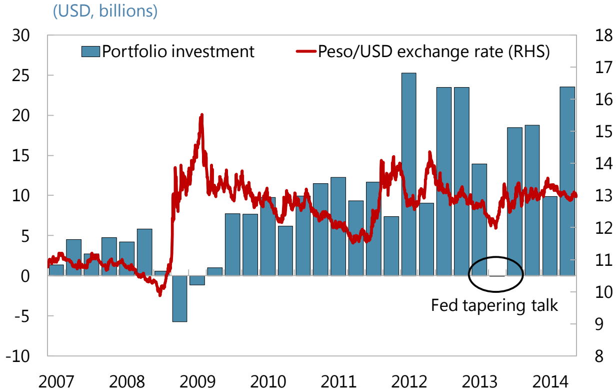
[14] Our result is consistent with the finding in the IMF's Regional Economic Outlook: Western Hemisphere (April 2014) that a shock in VIX (which may reflect global uncertainty) can have diffenrt impact from a shock in US interest rate.

[15] Monetary policy is guided by an inflation targeting framework under a flexible exchange rate, and fiscal policy is anchored by a fiscal responsibility law.

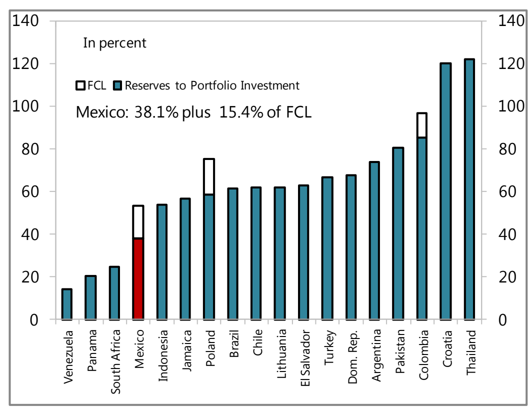
has one of the highest credit ratings among emerging markets. These strong fundamentals have helped attract foreigner investors and maintain a strong demand from local investors, especially during the periods of market stress. For example, during the GFC local investors reduced their holdings of foreign assets and brought local assets when foreigners left Mexican market. The situation was very different during the Mexican peso crisis in 2004, when both foreign and local investors deserted the country amid the great domestic policy uncertainty.

27. Country insurance against global risks may be necessary. While the exchange rate flexibility acted as an effective shock absorber, the high level of reserves has provided a useful buffer against temporary stress in foreign exchange markets.[16] The FCL arrangement, which the authorities continue to treat as precautionary, was an important complement to reserve buffers, providing additional protection against tail risks. For instance, in the aftermath of the announcements by Federal Reserve Board members about imminent tapering, capital inflows by non-residents dropped by US$24.5 billion from Q1to Q2 2013. The exchange rate depreciated by 8 percent. Both of these developments were quickly reversed, as investors began differentiating between emerging markets, and Mexico stood out for its strong macroeconomic fundamentals, but also its large foreign exchange buffer, notably when including the FCL.

Gross Portfolio Inflows by Foreigners
(USD, billions)



Source: Haver Analytics.



28. Finally, a deep and diverse domestic investor base is important as well. Mexico has benefited from an expanding and diverse local investor base, thanks to pension reforms and the establishment of insurance and mutual fund industries. These investors could play a more important stabilizing role to the Mexican financial markets, for example, by improving liquidity in the secondary markets for government securities.

[16] International reserves stand at about US$190bn as of June 2014.

Box 1. OLS and Multivariate GARCH Models

Weekly OLS regression with within-week volatility:

$$Vol_t^{Mex} = Cons + \alpha_1 Z_t + \sum_{i=1}^{I}(\alpha_{2i} \times S_{i,t-1} \times Z_t \times Stress_t) + \sum_{i=1}^{I}[\alpha_{3i} \times S_{i,t-1} \times Z_t \times (1 - Stress_t)] + \alpha_4 X_t + \varepsilon_t$$

where: Vol^{Mex} is the within-week volatility of Mexican 10-year sovereign bond yields; Z denotes the global financial shocks measured by VIX and the *within-week volatility* of U.S. 10-year Treasury yields; S_i represents the holdings of long-term (LT) Mexican sovereign bonds by each type of investors as a share of total outstanding bond values; $Stress$ is a dummy variable which takes the value of 1 if it's the period with extreme capital flows (referred to as extreme periods hence after) and 0 if it's not; X is the change in Mexico's international reserves, as a domestic variable to control for partly the supply of sovereign bonds. We use the first lag of investors' shares of holdings to avoid the endogeneity problem due to the potential impact of volatility on investors' holdings.

Daily OLS regression with 5-day rolling volatility:

$$Vol_t^{Mex} = Cons + \beta_1 Z_t + \sum_{i=1}^{I}(\beta_{2i} \times S_{i,t-4} \times Z_t \times Stress_t) + \sum_{i=1}^{I}[\beta_{3i} \times S_{i,t-4} \times Z_t \times (1 - Stress_t)] + \beta_4 X_t + \varepsilon_t$$

Where: Z denotes the global financial shocks measured by VIX and the *5-day rolling volatility* of U.S. 10-year Treasury yields; X is the first-order log difference of the exchange rate. The 4th lag of investors' shares of holdings is used to avoid the endogeneity problem.

Multivariate GARCH Model (MGARCH): To jointly and systematically model both bond market and equity market returns, as well as the levels and (conditional) volatilities of these returns.

- **The mean equation:**

$$\begin{bmatrix}\Delta Y_t^{Mex}\\ \Delta E_t^{Mex}\end{bmatrix} = \begin{bmatrix}Cons_y\\ Cons_E\end{bmatrix} + A_1 Z_t + \sum_{i=1}^{I}(A_{2i} \times S_{i,t-1} \times Z_t \times Stress_t) + \sum_{i=1}^{I}[A_{3i} \times S_{i,t-1} \times Z_t \times (1 - Stress_t)] + A_4 X_t + \begin{bmatrix}\varepsilon_{y,t}\\ \varepsilon_{E,t}\end{bmatrix}$$

where: ΔY^{Mex} denotes the (daily) change in the Mexican 10-year sovereign bond yields, and ΔE^{Mex} denotes the (daily) first-order log difference of the Mexican stock prices; Z denotes the global financial shocks to domestic asset returns measured by VIX and the (daily) change in U.S. 10-year Treasury yields; X is the first-order log difference of the exchange rate.

- **The volatility equation:** We assume a diagonal conditional variance matrix where each diagonal element follows a GARCH(1, 1) process with exogenous regressors, and also assume a constant conditional correlation between the two asset returns for simplicity.

$$\begin{bmatrix}\sigma_{Y,t}^2\\ \sigma_{E,t}^2\end{bmatrix} = \begin{bmatrix}Cons_y\\ Cons_E\end{bmatrix} + B_1\begin{bmatrix}\sigma_{Y,t-1}^2\\ \sigma_{E,t-1}^2\end{bmatrix} + B_2\begin{bmatrix}\varepsilon_{Y,t-1}^2\\ \varepsilon_{E,t-1}^2\end{bmatrix} + B_3 Z_t + \sum_{i=1}^{I}(B_{4i} \times S_{i,t-1} \times Z_t \times Stress_t) + \sum_{i=1}^{I}[B_{5i} \times S_{i,t-1} \times Z_t \times (1 - Stress_t)] + B_6 X_t$$

where: $\sigma_{Y,t}^2$ and $\sigma_{E,t}^2$ are the conditional variances of ΔY_t^{Mex} and ΔE_t^{Mex}, respectively; Z denotes the global financial shocks to these conditional variances measured by VIX and the conditional volatility of U.S. 10-year Treasury yields.

Box 2. Data on Foreign Mutual Funds

- Our data source for foreign mutual funds is EPFR Global. It covers in total about 11,000 equity funds and about 4,500 bond funds, all of which have $22 trillion in total assets as of the end of 2013. According to EPFR Global, its data track more than 95 percent of EM-focused bond and equity funds. EPFR data have several advantages over Balance of Payments data. First, EPFR Global provides high-frequency (weekly or monthly), detailed information at the fund-level. Second, it records data on a nationality basis, while the Balance of Payments data report in a residency basis.

- A drawback of EPFR Global is that it generally tracks only mutual funds. However, this is not necessarily critical since mutual funds have been playing an important role in capital flows to Mexico. Moreover, the behavior of mutual funds itself is an important research agenda, since IMF (2014) reports that they are more sensitive to global financial conditions and are more likely to engage in return chasing than other types of investors.

- EPFR Global provides various fund-level and country-level data. We use two different fund-level data sets: the fund flow data, and the country allocation data. The fund flow data set reports dollar-denominated flows, returns, assets under management (AUM), in addition to various fund characteristics, such as the domicile and geographic focus. However, the flows, returns, and AUM are not disaggregated by destination economy. On the other hand, the country allocation data set reports country allocation weights over more than 130 developed and emerging economies on a monthly basis.

- EPFR Global also provides country-level data, which are estimated using the two fund-level data sets. It also enables us to obtain the country-level data decomposed by fund characteristics. Roughly speaking, EPFR Global estimates country-level flows by multiplying the country allocation weight at the end of month by the aggregate flow into funds with specific characteristics. Although the country-level data are useful, a potential drawback is that the estimation method generally can only capture changes in flows from ultimate investors but not changes in allocation weights. Hence, if asset managers shift their allocations from EM economies to advanced economies or cash in response to some deterioration in global financial conditions, the estimated outflows from EM economies are underestimated.

Table 1a. Bond Funds: Evidence of Positive Feedback Trading Behavior

Explanatory Variables	Domestic Funds		Foreign Funds	
	(1)	(2)	(1)	(2)
	Fund Flow	**Fund Flow**	**Fund Flow**	**Fund Flow**
Lagged Mex 3-month bond yield	0.00726	0.00628	0.00725***	0.00660***
	(0.00541)	(0.00543)	(0.000765)	(0.000770)
Lagged bond yield * Stress		0.00481**		0.0171***
		(0.00225)		(0.00567)
Stress		-0.0177*		-0.0677***
		(0.00945)		(0.0229)
Constant	-0.0205	-0.0166	-0.0288***	-0.0260***
	(0.0220)	(0.0221)	(0.00319)	(0.00321)
Fund Fixed Effects	YES	YES	YES	YES
Number of Observations	20202	20202	3422	3422
R-squared	0.019	0.019	0.172	0.178

Standard errors (robust) in parentheses *p<0.10 **p<0.50 ***p<0.01
Sample size: 2011 January – 2014 March (stress episode: tapering announcement)

Table 1b. Equity Funds: Evidence of Positive Feedback Trading Behavior

Explanatory Variables	Domestic Funds		Foreign Funds	
	(1)	(2)	(1)	(2)
	Fund Flow	**Fund Flow**	**Fund Flow**	**Fund Flow**
Lagged stock market return	-0.0211*	-0.0269**	0.00228**	0.000615
	(0.0115)	(0.0123)	(0.00113)	(0.00105)
Lagged stock market return * Stress		-0.0986*		0.0138**
		(0.0517)		(0.00657)
Stress		-0.00417***		-0.0000949
		(0.00128)		(0.000118)
Constant	0.00236***	0.00251***	-0.000143***	-0.000102**
	(0.000351)	(0.000377)	(0.0000375)	(0.0000398)
Fund Fixed Effects	YES	YES	YES	YES
Number of Observations	18018	18018	18595	18595
R-squared	0.083	0.084	0.140	0.140

Standard errors (robust) in parentheses *p<0.10 **p<0.50 ***p<0.01

Sample size: 2011 January – 2014 March (stress episode: tapering announcement)

Table 2a. Robustness Check (1)—Using a Longer Sample for Foreign Mutual Funds				
Explanatory Variables	**Foreign Bond Funds**		**Foreign Equity Funds**	
	(1)	(2)	(1)	(2)
	Fund Flow	**Fund Flow**	**Fund Flow**	**Fund Flow**
Lagged return	0.000557***	0.000557***	0.0172***	0.00127*
	(0.000204)	(0.000204)	(0.00604)	(0.000673)
Lagged return * Stress		0.0263***		0.00235*
		(0.00625)		(0.00129)
Stress		-0.101***		-0.000202
		(0.0237)		(0.000137)
Constant	-0.00346**	-0.00346**	0.000445**	0.0000105
	(0.00157)	(0.00157)	(0.000213)	(0.0000303)
Month Fixed Effects	YES	YES	YES	YES
Fund Fixed Effects	YES	YES	YES	YES
Number of Observations	7287	7287	38724	38724
R-squared	0.220	0.220	0.075	0.070

Standard errors (robust) in parentheses *p<0.10 **p<0.50 ***p<0.01
Sample size: 2005 January – 2014 March
(Stress episodes: global financial crisis & tapering announcement)

Table 2b. Robustness Check (2) – Using dollar-denominated return on the 3-month Government Bonds

Explanatory Variables	Domestic Funds		Foreign Funds	
	(1)	(2)	(1)	(2)
	Fund Flow	Fund Flow	Fund Flow	Fund Flow
Lagged dollar return on Mex 3-month govt bonds	0.0355	0.0206	0.0705***	0.0668***
	(0.0579)	(0.0581)	(0.00803)	(0.00806)
Lagged bond yield * Stress		0.0592**		0.261***
		(0.0280)		(0.0701)
Stress		-0.0192**		-0.0852***
		(0.00947)		(0.0228)
Constant	-0.00215	0.00267	-0.0218***	-0.0204***
	(0.0184)	(0.0185)	(0.00261)	(0.00261)
Fund Fixed Effects	YES	YES	YES	YES
Number of Observations	20202	20202	3422	3422
R-squared	0.019	0.019	0.168	0.176

Standard errors (robust) in parentheses *p<0.10 **p<0.50 ***p<0.01

Sample size: 2011 January – 2014 March (stress episode: tapering announcement)

Table 3a. OLS Regression Results (VIX Shock)

Explanatory variables	OLS Regressions	
	With-week volatility	**5-day rolling volatility**
VIX*Foreign share*Stress	0.0059*** (6.56)	0.0053*** (7.13)
VIX*Pension share*Stress	-0.0073* (1.89)	-0.0071* (1.83)
VIX*Mutual share*Stress	0.0045 (1.25)	0.0037 (1.47)
VIX*Insurance share*Stress	-0.0014 (0.72)	-0.0016 (0.73)
VIX*Bank share*Stress	-0.0047** (2.18)	-0.0037** (2.73)
VIX*Other share*Stress	0.0020* (1.69)	0.0022* (1.67)
VIX*Foreign share*Non-Stress	0.0021*** (5.33)	0.0023*** (7.13)
VIX*Pension share*Non-Stress	0.00052 (0.76)	0.00024 (0.43)
VIX*Mutual share*Non-Stress	-0.00049 (1.02)	-0.00063 (1.56)
VIX*Insurance share*Non-Stress	-0.0059*** (3.80)	-0.0063*** (5.04)
VIX*Bank share*Non-Stress	0.0014* (1.91)	0.0014** (2.44)
VIX*Other share*Non-Stress	-0.00 (0.094)	0.00011 (0.37)
Change in short-term interest rate	0.18 (1.16)	0.22 (0.90)
Change in reserves	-0.00* (1.89)	
Exchange rate depreciation		-0.078*** (2.79)
Constant	0.14 (1.45)	0.14* (1.71)
Adjusted R^2	0.33	0.32

Note: t-statistics in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

Table 3b. OLS Regression Results (U.S. Tapering Shock)

Explanatory variables	OLS Regressions	
	With-week volatility	**5-day rolling volatility**
Volatility of U.S. 10-year bond yields* Foreign share*Stress	0.043*** (4.78)	0.040* (5.57)
Volatility of U.S. 10-year bond yields* Pension share*Stress	-0.023 (0.71)	-0.059 (1.46)
Volatility of U.S. 10-year bond yields* Mutual share*Stress	-0.026 (0.83)	-0.012 (0.53)
Volatility of U.S. 10-year bond yields* Insurance share*Stress	-0.0065 (0.16)	0.0076 (0.18)
Volatility of U.S. 10-year bond yields* Bank share*Stress	-0.074 (1.61)	-0.054** (2.26)
Volatility of U.S. 10-year bond yields* Other share*Stress	0.021 (1.43)	0.034* (1.81)
Volatility of U.S. 10-year bond yields* Foreign share*Non-Stress	0.0058 (1.43)	0.0095*** (2.96)
Volatility of U.S. 10-year bond yields* Pension share*Non-Stress	0.0076 (0.74)	-0.00 (0.0069)
Volatility of U.S. 10-year bond yields* Mutual share*Non-Stress	-0.011 (1.61)	-0.012** (2.04)
Volatility of U.S. 10-year bond yields* Insurance share*Non-Stress	-0.0096 (0.46)	-0.018 (1.16)
Volatility of U.S. 10-year bond yields* Bank share*Non-Stress	0.015** (1.96)	0.014** (2.14)
Volatility of U.S. 10-year bond yields* Other share*Non-Stress	-0.0044 (0.79)	0.00019 (0.046)
Change in short-term interest rate	0.19 (1.11)	0.22 (0.84)
Change in reserves	-0.00* (1.76)	
Exchange rate depreciation		-0.052* (1.67)
Constant	0.61*** (8.45)	0.60*** (16.08)
Adjusted R^2	0.25	0.22

Note: t-statistics in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

Table 4a. Multivariate GARCH Results (VIX Shock)

Explanatory variables	**III-A** ΔY_t^{Mex}	**IV-A** $\sigma_{Y,t}^2$
VIX*Foreign share*Stress	-0.0013 (0.39)	0.0079*** (9.13)
VIX*Pension share*Stress	0.025* (1.67)	0.0036 (0.70)
VIX*Mutual share*Stress	-0.0090 (0.62)	-0.0024 (0.55)
VIX*Insurance share*Stress	-0.015* (1.70)	-0.011*** (3.54)
VIX*Bank share*Stress	-0.022*** (2.86)	-0.0099*** (3.25)
VIX*Other share*Stress	-0.0079** (2.04)	-0.00044 (0.35)
VIX*Foreign share*Non-Stress	-0.0037** (2.13)	0.0053*** (8.18)
VIX*Pension share*Non-Stress	-0.0038 (1.07)	-0.00045 (0.49)
VIX*Mutual share*Non-Stress	-0.0059** (2.31)	-0.0042*** (4.77)
VIX*Insurance share*Non-Stress	0.020*** (2.63)	-0.018*** (6.66)
VIX*Bank share*Non-Stress	0.0010 (0.32)	0.0078*** (7.72)
VIX*Other share*Non-Stress	0.00064 (0.34)	0.00068 (1.32)
Change in short-term interest rate	2.42 (1.39)	0.20 (0.34)
Exchange rate depreciation	2.87*** (16.84)	0.0030 (0.04)
ARCH term		0.25*** (8.34)
GARCH term		0.30*** (6.05)
Constant	1.88*** (4.08)	1.39*** (7.87)

Note: t-statistics in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively

Table 4b. Multivariate GARCH Results (U.S. Tapering Shock)

Explanatory variables	**IIII-B**	**IV-B**
	ΔY_t^{Mex}	$\sigma_{Y,t}^2$
U.S. 10-year bond yields*Foreign share*Stress 1/	0.016* (1.63)	3.73*** (5.58)
U.S. 10-year bond yields*Pension share*Stress	0.076* (1.83)	2.04 (0.65)
U.S. 10-year bond yields *Mutual share*Stress	-0.020 (0.48)	-7.55** (2.31)
U.S. 10-year bond yields *Insurance share*Stress	-0.020 (0.71)	-0.75 (0.38)
U.S. 10-year bond yields *Bank share*Stress	-0.053** (2.11)	-3.54 (1.33)
U.S. 10-year bond yields *Other share*Stress	-0.027** (2.48)	2.57** (2.34)
U.S. 10-year bond yields *Foreign share*Non-Stress	0.015*** (2.98)	1.49*** (2.65)
U.S. 10-year bond yields *Pension share*Non-Stress	0.0036 (0.33)	-0.49 (0.86)
U.S. 10-year bond yields *Mutual share*Non-Stress	-0.012 (1.53)	-0. 77 (1.14)
U.S. 10-year bond yields *Insurance share*Non-Stress	0.0051 (0.27)	-1.70* (1.76)
U.S. 10-year bond yields *Bank share*Non-Stress	0.023** (2.14)	2.44*** (4.04)
U.S. 10-year bond yields *Other share*Non-Stress	-0.0049 (0.85)	1.41** (2.43)
Change in short-term interest rate	2.90* (1.71)	2.25** (2.54)
Exchange rate depreciation	3.44*** (18.95)	0.50*** (3.44)
ARCH term		0.26*** (7.83)
GARCH term		0.56*** (10.95)
Constant	-0.18* (1.85)	-2.84 (1.07)

1/ The “U.S. 10-year bond yields” denotes the change in U.S. 10-year bond yields and the volatility of U.S. 10-year bond yields in columns III-B and IV-B, respectively.

Note: t-statistics in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

References

Andritzky, Jochen R. (2012), "Government Bonds and Their Investors: What Are the Facts and Do They Matter?" IMF Working Papers, WP/12/158, June.

Bikhchandani, Sushil, David Hirshleifer, and Ivo Welch, 1992, "A Theory of Fads, Fashion, Custom and Cultural Change as Information Cascades," *Journal of Political Economy,* Vol. 100, No. 5, pp. 992–1026

Cont, Rama, (2005), "Volatility Clustering in Financial Markets: Empirical Facts and Agent-Based Models",

Ebeke, Christian and Yinqiu Lu, (2014), "Emerging Market Local Currency Bond Yields and Foreign Holdings in the Post-Lehman Period—a Fortune or Misfortune", IMF Working Papers, WP/14/29, February.

Faruqee, H., Li, S., and I.K. Yan, (2004), "The Determinants of International Portfolio Holdings and Home Bias", IMF Working Papers, WP/04/34, February.

Forbes, Kristin J., and Francis E. Warnock, (2012), "Capital Flow Waves: Surges, stops, flight, and retrenchments", Journal of International Economics 88: 235-251.

Frankel, J., (1982), "A Search of the Exchange Risk Premium: A Six-Currency Test Assuming Mean-Variance Optimization", Journal of International Money and Finance, Vol. 1, pp. 255–274.

Gelos, Gaston, (2011), "International Mutual Funds, Capital Flow Volatility, and Contagion—A Survey", IMF Working Papers, WP/11/92, April.

Hsieh, Meng-Fen, Tzu-Yi Yang, Yu-Tai Yang, and Jen-Sin Lee, 2011, "Evidence of Herding and Positive Feedback Trading for Mutual Funds in Emerging Asian Countries," *Quantitative Finance*, Vol. 11, No. 3, pp. 423-435.

International Monetary Fund, (2014), "How Do Changes in the Investor Base and Financial Deepening Affect Emerging Market Economies", Chapter 2 in Global Financial Stability Report, April.

Kim, Woo-Chan, and Shang-Jin Wei (2002), "Foreign portfolio investors before and during a crisis", Journal of International Economics 56: 77–96.

Maug, Ernst, and Narayan Naik, 2011, "Herding and Delegated Portfolio Management: The Impact of Relative Performance Evaluation on Asset Allocation," *Quarterly Journal of Finance*, Vol. 1, No. 2, pp. 265–92.

Milesi-Ferretti, Gian-Maria and Cedric Tille, 2011, "The great retrenchment: international capital flows during the global financial crisis", Economic Policy, Volume 26, Issue 66, pages 289–346, April.

Peiris, Shanaka J. (2010), "Foreign Participation in Emerging Markets' Local Currency Bond Markets," IMF Working Papers, WP/10/88, April.

Prasad, Eswar S., and Raghuram G. Rajan (2008). "A Pragmatic Approach to Capital Account Liberalization." *Journal of Economic Perspectives*, 22(3): 149-72

Scharfstein, David, and Jeremy Stein, 1990, "Herd Behavior and Investment," *American Economic Review,* Vol. 90, No. 3, pp. 465–79.

Sidaoui, José, Julio Santaella and Javier Pérez, 2012, "Banco de México and recent developments in domestic public debt markets", BIS background paper.