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THE DISTRIBUTIONAL IMPACT OF MACROECONOMIC SHOCKS IN MEXICO: THRESHOLD EFFECTS IN A MULTI-REGION CGE MODEL

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ABSTRACT

This paper presents a regionally disaggregated computable general equilibrium (CGE) model of Mexico in order to examine the differential effects of external shocks across the regions. The model demonstrates how the internal migration regime is affected by exogenous changes in the presence of threshold effects, in which an exogenous change may not effect regional behavior until the shocks are large enough to overcome the isolation of local markets. The results show that migration helps mitigate the income changes caused by the simulations.

I. Introduction[1]

Computable General Equilibrium (CGE) country studies usually ignore the spatial dimensions of the economy. Empirical work, however, indicates that national policies or external shocks have very different effects across regions, depending on how closely linked the regions are to national markets. High transport and communications costs, for example, may partially isolate some regions. Thus, exogenous changes may not effect regional prices until the shocks are large enough to overcome the isolation of local markets. These threshold effects may lead to significant regional differences in the distributional impact of national policy changes.

Recently there have been a number of regionally disaggregated CGE models, in which "regions" are either within a country or represent several countries in a world model[2]. However, these models for the most part have not explicitly included geographical space, so that trade, production, and labor regimes (ie., the direction of the flows) present in the base solution will not be affected by exogenous changes. On the other hand, if "spatiality" is explicitly included, as will be demonstrated in this paper, these patterns may change. The direction of trade flows, for example, may become zero or reverse if distance and corresponding costs are taken into account. Transportation costs as well as trade flows can cause a region to cease production of a particular good and begin producing a new good.

Within a regionally disaggregated model of Mexico, this study will focus on labor flows. The model is constructed so that workers can migrate between regionalized agricultural labor markets and the urban unskilled labor market, allowing for regime changes. The model will show how the internal migration regime is affected differentially across regions in the face of external shocks or policy changes.

The model presented in this paper is based on a regionalized Social Accounting Matrix (SAM) for 1996, which has been estimated using maximum entropy techniques. The model differentiates production across five regions, four rural and a fifth “national” urban region. The rural regions are differentiated by their agricultural production technologies. There are three households in each region, disaggregated by income level, so the model can be used to explore distributional effects. The spatial CGE model uses a mixed complementarity specification to incorporate threshold effects and regime changes; namely, migration from one regional labor market to another where none existed in the base.

Mexico's foreign trade environment has undergone dramatic changes, starting with joining GATT in 1986 and continuing through the implementation of NAFTA in 1994 and

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[1]Prepared for the 2nd Annual Conference on Global Economic Analysis, Denmark, June 20-22, 1999. The author would like to thank Sherman Robinson for invaluable assistance and support in the preparation of this paper.

[2]See Isard, *et al.* (1998) and Löfgren and Robinson (1998) for a history of regional CGE models.

the peso crisis at the end of 1994. In addition, policy liberalization in the agricultural sector has decreased government intervention in both consumer and producer markets. The spatial CGE model, calibrated to 1996, is used to analyze the impact of macroeconomic shocks within the context of these recent reforms. The model is used to examine the effects of an exchange rate devaluation and regional productivity improvement, focusing on the distribution of income within and across regions (including the rural-urban divide).

This paper is organized as follows: after a description of migration issues in the Mexican context, section 3 describes the data and explains the construction of the social accounting matrix. Section 4 outlines the CGE model and section 5 describes the simulations and results. Section 6 concludes as well as posits ideas for future work.

II. Migration in Mexico

In recent years, Mexican migration to the United States has received much attention both in the popular press as well as in the academic literature. Indeed, a common claim in support of the NAFTA agreement was that one of its potential benefits would be reduced Mexico-U.S. migration. Internal migration has also played an important role in Mexico's economic and demographic development. It is estimated that about 150,000 rural Mexicans migrate to Mexico City alone each year, contributing to about one-third of the city's two percent annual growth rate.[3] In addition to rural workers looking for better opportunities in Mexico's cities, there is also some evidence of a two-stage migration, in which migrants first move toward the north of Mexico in order to make an easier second move to the U.S.[4]

Migration, whether internal or international, helps families diversify their income sources as a way of dealing with market failures.[5] In rural areas in which credit markets or insurance markets are imperfect, for example, migration can smooth out risks and assist the household to earn extra income in a way which is uncorrelated, if not negatively correlated, with farm income.

Adelman, Taylor, and Vogel (1988) discuss some of the characteristics of migrants from a village in Michoacán, Mexico. In their sample, internal migrants were better educated than either emigrants to the U.S. or those who stayed in the village. They found that the size of landholding also played a role in migration. The larger land-owning families, needing more laborers at home, were less likely to migrate. Medium-sized landholders, who did not need as many farm laborers, had a higher rate of migration, and tended to give them the highest income as well. Migration was critical for landless families: 30 percent of their income came from internal remittances, while 31 percent came from U.S. emigrants.

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[3]Morell (1996).

[4]Zabin and Hughes (1995).

[5]This section draws on Taylor (1995) and Jones (1998). For a review of studies on migration remittances and inequalities, see Jones (1998).

The migration literature shows that the effects of migration on well-being are mixed, depending on many variables. If remittance income is spent within the recipient village, then there can be positive multiplier effects from migration. This would be the case if the extra income is spent on investment goods, on locally produced goods, or other day-to-day expenditures. On the other hand, it may be that the remittance income is spent on goods which must be imported from either the urban area or outside the country. For example, the extra income may be used to buy luxury goods, consumer durables, and other goods which are not produced within the village. In this case, there would be a one-time increase in village income, without any secondary multiplier effects. The recipient's expenditure behavior depends to a large extent on his income level, as lower income families tend to spend their remittances on locally produced goods, and higher income recipients generally spend more of the remittance income on imported goods. On the other hand, wealthier recipients are more likely to use this additional income on investment expenditures (both physical and human capital).

Taylor (1988) shows, using the Michoacán data, that the major recipients of U.S.-originating remittances are the small-holder households, and that both they and large-holder households benefit from second-round effects as well. However, landless families receive only a small fraction of U.S. remittances, with very small second-round effects. With regard to remittances from internal migration, the landless families receive more first-round effects, but the multiplier effect is still very small. Large-holder households, who do receive the largest share of internal remittances, and small-holder families, who do not receive any internal remittances, gain greatly from the secondary effect of the remittance expenditures. In this village, the landless are clearly not well linked into the production of the goods demanded from extra money, such as manufactured goods.

As Jones (1998) demonstrates in his study of a village in Zacatecas, Mexico, the relationship between migration remittances and inequality may also be a function of the stage of migration. In the early stage of migration (the "innovator stage"), when few members of the village have migrated, those who do leave tend to be from wealthier families. Inequality worsens within the village as these migrants send remittances back to their already well-off families. As migration continues, migrants come from other classes on the income spectrum, and so, in this "Early Adopter Stage," inequality improves. Finally, in the "Late Adopter Stage," the village is divided between those who have sent family members outside and those who are too poor to participate in any migration. This dichotomy between a migrating class and a non-migrating class increases inequality. Throughout the continuum, however, rural-urban inequality is decreasing.

In the present study, the definition of migration is constrained by data availability. In this national model, there is no data on where migrant remittances come from (internal or international), so the study focuses on internal migration. In the base static solution, there is assumed to be no migration. When the model is shocked, the changes may induce a migration response between agricultural and unskilled labor markets (in both directions).

Rural households in Mexico derive much of their income from non-farm activities. In the model, all non-farm activities take place in the "national" market. Thus regional expenditure multipliers of remittance income cannot be explicitly observed. Instead, the CGE model will only capture the direct and indirect effects of migration on the production side of the economy.

III. Database and SAM Description

The model is based on a Social Accounting Matrix (SAM) of Mexico, based on 1996 data.[6] The SAM accounts for all income and expenditure transactions of all sectors and institutions in the economy, and thus serves as the underlying data framework for the CGE. The data were first collected as a national SAM, which was then divided into 5 regions. The model is able to capture differences among the regions in terms of production and consumption patterns, in a "top-down" approach. Rather than having complete regional SAMs, the model only regionally disaggregates the production, factor markets, and households. The current approach is suitable given the national and macroeconomic implications on which this study focuses.

The model includes four rural regions, North, Central, Southwest and Southeast, which produce only primary agricultural products. There is one “national” urban region, which comprises all of the urban areas of Mexico. The urban area produces processed agricultural goods and all other goods and services. Each rural region produces three agricultural goods: a high-value good (fruits and vegetables), a low-value good (basic grains), and a non-food good (cash crops such as cotton and coffee). There are three corresponding processed agricultural goods, which are produced in the urban region, plus eight other goods and services. The model incorporates regional agricultural production, with multiple production activities feeding into one national commodity. For example, all four rural regions produce the high-value crop, which they supply to a single national commodity market.

There are four types of non-agricultural labor: professional, white-collar, blue-collar, and unskilled/informal (which will be referred to as "unskilled"), and four agricultural labor categories, differentiated by region. The agricultural activities do not employ any non-agricultural labor and non-agricultural activities do not use any agricultural labor. Each rural region uses two types of land, irrigated and non-irrigated, for a total of eight land types. There is one capital category, used by all sectors. The model may be thought of as short to medium-term in nature, since labor is assumed to be mobile across sectors, but capital and land are not.

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[6]The data sources used in constructing the SAM include: “Sistema de Cuentas Nacionales de México,” Instituto Nacional de Estadística, Geografía e Informática (INEGI), 1996, for national accounts data and other macro data; Informe Anual, Banco de México, 1996 for macro data; Secretaría de Agricultura y Ganadería y Desarrollo Rural, 1996, for data on crop yields and land utilization; Encuesta Nacional de Ingresos y Gastos de Hogares, INEGI, 1994, for household income and expenditure data; GTAP database for import and export data. The input-output coefficients come from a 1985 I-O table.

Each region has three households, poor, medium, and rich. The delineation among the categories comes from national data. The poor are those in the lowest 40% income bracket of the entire country, regardless of their location; the medium earn the next 40% of income; the rich households earn the top 20% of income. Given this specification, distributional impacts of different scenarios can be observed among income groups as well as among regions. The rural regions get labor income from all labor types, with distribution shares estimated from national survey data. Poor rural households receive 45% of the agricultural returns to dry land in their region, while medium rural households receive 55% of dry land income. All of the irrigated land payments go to the rich households. The model also includes a livestock-forestry-fishery composite sector at the national level (due to data availability). Its land returns (to dry land) are split among the regional rich and medium income households. Rural households also receive capital income indirectly through enterprises. Urban households do not receive any agricultural labor income; the other labor categories distribute payments to the households according to shares estimated by the national survey. Urban households do not receive any land income, and, like their rural counterparts, receive distributed profits via the enterprise account.

Household consumption patterns also come from parameters estimated from survey data. Rural households have home consumption of agricultural; all other goods are bought on the national market. All households save according to parameters estimated from household survey data.

The government and enterprise accounts complete the set of domestic institutions in the SAM. The government, which is national, collects seven types of taxes: a value-added tax, a producer tax, an export tax, a sales tax, an import tariff, a social security tax, and an income tax. It receives transfers from the rest of the world and provides transfers to households and enterprises. The rest of the world account provides transfers to households, buys Mexico's exports, and sells imports.

The data for the SAM come from many disparate sources, and there were serious consistency problems ― the data did not satisfy basic "adding up" conditions. The SAM was balanced using maximum entropy techniques to incorporate prior knowledge in a consistent framework.[7]

Generally, the northern part of Mexico produces more of the higher value crops (in particular, fruits and vegetables), most of the land use is irrigated, and households are wealthier. The southern part of the country tends to be poorer, with more subsistence farming and less commercial agriculture. Table 1 gives data on cropping patterns according to the SAM disaggregation. The North region produces most of the high-value crop. The Southeast region produces the highest share of the non-food crop. The Central and Southwest regions produce the most of the low-value crop.

[7] See Robinson, Cattaneo, and El-Said (1998).

Table 1. Share of Crop-Types in Total Crop Production by Region

(in percent)

Crop-Type:	High-Value	Low-Value	Non-Food
Regions:			
North	32	23	20
Central	24	31	26
Southwest	24	32	27
Southeast	20	14	27

Source: Social Accounting Matrix constructed by author.
Note: Columns sum to 100%.

Table 2 shows that households get their income from a variety of sources. In particular, rural households do not receive only agricultural income; rather, they are active participants in the national labor and capital markets. Note that value-added capital includes "profits" from self-employment, which ranges from informal sector activities to professional services, as well as financial flows.

IV. Description of the CGE Model

The computable general equilibrium model used in this study is formulated as a non-linear, mixed complementarity problem. The equations of the model, which are solved simultaneously, are both linear and non-linear, and are a mixture of strict equalities and inequalities that are linked to bounded variables in complementarity slackness conditions. A simple example of a complementarity problem is in a non-regionalized country's export price equation. The domestic price should be greater than or equal to the world price of the good, and the complementarity constraint is that the quantity exported is greater than or equal to zero. If the domestic price is greater than the world price, exports will be zero, but if there are positive exports, it must be the case that the domestic price is exactly equal to the world price.

In this paper, the mixed complementarity component of the model is confined to the regional labor supply and migration equations, which will be described following a brief description of the rest of the model.[8]

The model is Walrasian, determining only relative prices. Product prices, factor prices, and the equilibrium exchange rate are defined relative to the consumer price index, which is the numeraire. The country is "small" in that it takes world prices as given. The production technology is a nested function of constant elasticity of substitution (CES) and Leontief functions. At the top level, domestic output is a linear combination of value added and intermediate inputs. Value added is a CES function of primary factors (land, labor, and

[8]The mathematical details of the rest of the model may be obtained from the author upon request.

capital) and intermediate inputs are demanded according to fixed input-output coefficients. The commodity output is a composite of different activities, which are imperfectly substitutable. This treatment allows for multiple activities (for example, a North region low-value activity and a South region low-value activity) to produce a single commodity (in this example, a “national” low-value commodity). Producers supply their output to the export and domestic markets according to a constant elasticity of transformation (CET) function, which allows some degree of independence from international prices. The composite consumption good is a CES function of imported and domestically produced commodities. This aggregation, known as the Armington function, permits imperfect substitutability, and therefore two-way trade, between imported and domestically produced goods.

Table 2: Household Income Sources by Factor

(as percentage of total household income)

Households / **Factors:**	**LPRO**	**LAGRA**	**LWCO**	**LBCO**	**LUNS**	**DLAND**	**ILAND**	**ENTR**
UP	7		17	23	19			34
UM	16		25	16	12			31
UR	44		31	5	0			19
RP-N	4	15	8	19	28	2		24
RM-N	12	11	15	9	15	26		12
RR-N	5	8	3	5	4	15	53	6
RP-C	3	8	5	16	47	4		18
RM-C	5	6	20	7	25	15		21
RR-C	3	2	18		17	5	30	25
RP-SW	2	9	5	19	50	6		9
RM-SW	7	9	11	15	29	10		19
RR-SW	1	8	7	26	27	3	7	20
RP-SE	2	10	5	15	39	5		24
RM-SE	11	6	20	17	11	10		25
RR-SE	18	6	13	22	3	2	3	33

Source: Social Accounting Matrix constructed by author.
Note: Rows sum to 100%

Abbreviations:

Households		Factors	
UP	Urban Poor	LPRO	Professional Labor
UM	Urban Medium	LAG	Agricultural Labor
UR	Urban Rich	LWCO	White Collar Labor
RP	Rural Poor	LBCO	Blue Collar Labor
RM	Rural Medium	LUNS	Unskilled/Informal Labor
RR	Rural Rich		
Regions			
-N	North		
-C	Central		
-SW	Southwest		
-SE	Southeast		

Households receive income from factor payments (labor, land, and capital payments) net of factor taxes, government transfers, and transfers from the rest of the world. They consume goods according to a linear expenditure function, purchasing goods from the market, as well as from home production (in rural regions only). They also pay taxes on their monetary income and save a share of their total income. Enterprises receive capital income minus capital payments to the rest of the world, as well as government transfers. Enterprises transfer that payment, net of depreciation and taxes, to households. Government income is the sum of all taxes: direct taxes on households and enterprises, value-added taxes, producer taxes, import tariffs, export taxes, social security taxes, factor taxes, and sales taxes. The government's expenditure is composed of demand for goods and services, transfers to domestic institutions, and transfers to the rest of the world. The macro closure of the model fixes both investment and government spending as a share of total absorption. This method "spreads out" the adjustment, since an external shock will affect investment, consumption, and savings similarly.

The model structure to allows labor migration between the rural regions and the urban region (in either direction), with a threshold effect of wage differences. Agricultural laborers from the four regions can migrate to the urban unskilled labor market and vice versa. Typically in CGE models, a laborer's decision to migrate is based on the wage differential between what he is currently earning and what he would potentially earn if he moved. In this model, there are bounds on the earnings differential, inside of which the laborer will not move. This specification captures the fact that there may be a threshold effect on migration: it is likely that, within a range, changes in wages will not induce a laborer to move until the wage differential reaches some threshold.[9] Migration can occur in both directions, so if the wage differential between agricultural labor (in a given region) and the urban unskilled labor increases beyond a certain point, agricultural laborers will migrate out of their rural region but if the wage differential shrinks below a lower bound, unskilled laborers will migrate to the rural region. This model captures net flows of migration between any two regions and implicitly includes cross-region migration (for example, a migrant might move from his regional agricultural labor market to the urban labor market and from there to a different regional agricultural labor market).

The equations for labor migration are set up as a mixed-complementarity problem, in which the wage differentials are written as inequalities and linked to the migration variables in complementarity slackness conditions. The set of migration equations are displayed in Table 3.

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[9]While this analysis does not explicitly take into account expected wages, as in a Harris-Todaro framework, or any other factors of the migration decision, such as preferences, urban crowding, distance from family, etc., these may be implicitly captured by the threshold effect.

Table 3: Labor Migration Equations

$AVWF_{lab} = [WGDFL_{lab,labp}(1 + DWG_{lab,labp}) \bullet AVWF_{labp}]$	(1)
$DWG_{smig,rmig} \leq 0.01,$ $MIG1 \leq 0$	(2)
$DWG_{smig,rmig} \geq -0.01,$ $MIG2 \geq 0$	(3)
$MIGRU_{smig} = \sum_{rmig}(-MIG\,1_{smig,rmig} - MIG\,2_{smig,rmig})$	(4)
$QFS_{lab} = QFS\,0_{lab} + MIGRU_{lab}$	(5)
$\sum_{lab} MIGRU_{lab} = 0$	(6)

The first equation shows that the initial average wage in one labor category[10], $AVWF_{lab}$, is equal to a wage differential, $WGDFL_{lab,labp}$, multiplied by one plus a bounded variable, $DWG_{lab,labp}$, multiplied by the initial average wage in the urban unskilled labor category. In the base, DWG equals zero by assumption and there is no migration. If, as a result of a simulation, the wage differential changes, then DWG will also change in the opposite direction to keep the equation balanced. For example, suppose initially the average agricultural wage is 1.0 and the average unskilled labor wage is 2.5. Thus the wage differential ratio is 0.4. Now, if there is an increase in unskilled wages to 3.0, the ratio falls to 0.33. DWG will now equal 0.175 in order to maintain the equality of the initial average wages.

Equations 2 and 3 further elaborate on the bounds for DWG. Here it is set to be between -0.01 and +0.01, which, in this setting, can be thought of as a one percent change (positive or negative) in the wage differential ratio. The complementary slackness conditions for these equations are also presented, showing that as long as DWG remains within its bounds, migration will be zero. If DWG hits either of the bounds, then there will be migration. If the wage differential decreases (for example, if urban unskilled wages rise), DWG compensates by becoming positive. If DWG reaches 0.01, there will be positive migration out of the rural area. When it reaches the bound, the wage differential has grown enough to induce migrants to leave the rural region. Similarly, if DWG reaches -0.01, the wage differential has reached a threshold that induces urban migrants to move to the rural region.

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[10]In this study, agricultural labor is defined by region, thus "labor category" refers to the set of labor types including four separate agricultural labor types, one from each rural region.

Equation 4 adds up all of the migrants that could enter or leave a labor market. Equation 5 adds (or subtracts) that figure from the total labor supply of the category, to get the new labor supply after migration. Equation 6 ensures that the net sum of migration among categories is zero. If there is a positive migration from the rural area to the urban area, there is "negative" migration from the urban area to the rural area. In this analysis, there are four rural areas, so the sum of the rural migration should equal the sum of negative urban migration.

V. Simulations

Two simulations are performed to see how external shocks will have differential effects across the regions. The first is a devaluation experiment. In this case, the shock directly affects the whole country, but the regions are impacted differently. Next, a region-specific shock is simulated in which the high-value agricultural sector of the North region has an improvement in productivity, but all other sectors and regions remain the same. Here, the shock obviously directly affects only the North region, but there are strong indirect effects, particularly in the Central region. Both simulations are performed with and without potential migration between the agricultural and unskilled urban labor markets.[11]

A. Devaluation

i. Without Labor Migration

The model is first used to show the regional effects of a 25% devaluation of the peso, in 5% increments. As expected, the devaluation causes a contraction of the economy, with all macroeconomic indicators falling except for exports. As a result of the devaluation, exports rise and imports fall, leading to an improvement in the balance of trade. This forces absorption to fall, and because of the balanced macro closure, this causes consumption and government spending to fall as well (by 17% and 11% respectively, in real terms). Since the price of imports increases, imports decline by 11% after the 25% devaluation. The fall in imports is tempered by the import intensity of Mexico's export sector. That is, in order to

[11]It should be noted that in the migration simulations, the data do not tell us if a migrant has actually moved locations, either temporarily or permanently. It is possible for a person who switches from agricultural work to unskilled work to remain in the rural area. Indeed rural households receive a substantial portion of their income from unskilled labor even under the no-migration scenario. Furthermore, there is no information on how much of a migrants worker's income is sent back to his place of origin in the form of remittances. In these simulations, we maintain the base-year distribution of labor-type income, thus assuming that when a migrant moves, he is not necessarily part of his original household. This is most obviously seen in the unskilled-to-agricultural labor migration, in which possibly urban individuals are now receiving agricultural wages. In the model, this is seen as an increase in rural income, since the original distribution of agricultural wages excludes urban households, and thus, the urban worker has been incorporated into the rural region.

achieve the increase in exports which results from the devaluation, the country still must import intermediate goods necessary to produce more export goods.

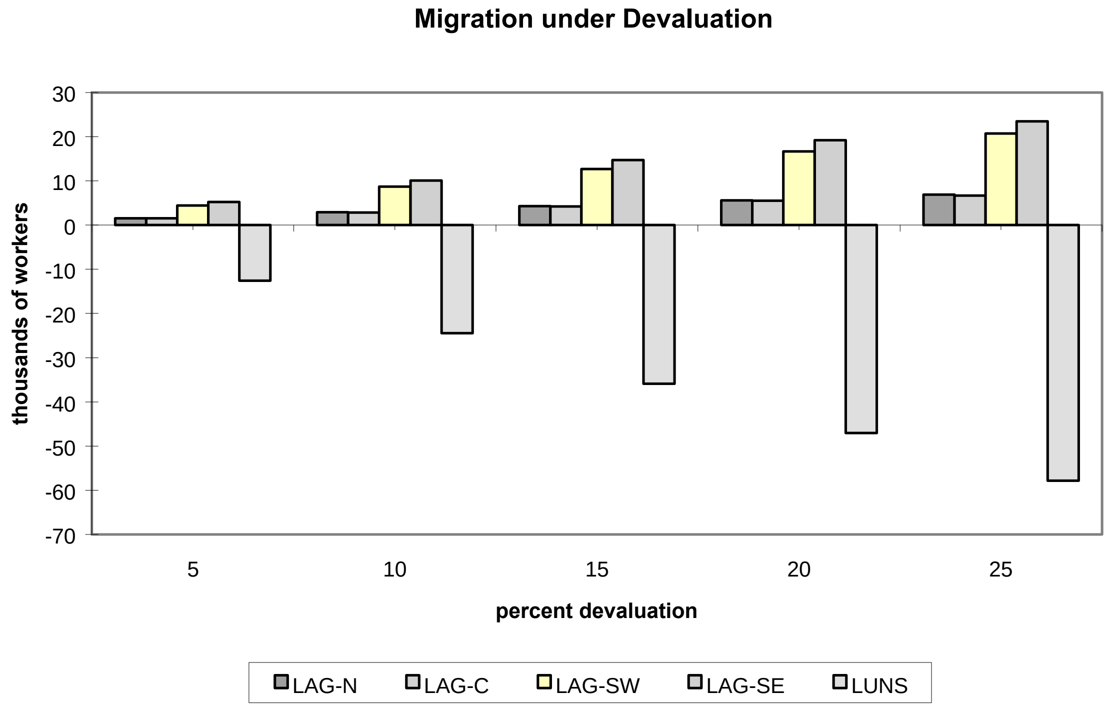
Generally, agriculture benefits from the devaluation, both because more of the high-value good and the non-food good see a rise in export demand and because there are backward linkages through the processed agricultural sectors, whose export demand rises with the devaluation. However, the benefits are not evenly distributed across agricultural sectors or across the regions. In particular, the highly-exportable non-food crop expands output, with the largest increase coming from the Southeast. Meanwhile, the low-value crop - which is not highly exported - decreases its production, in order to divert resources to the non-food crop. Of the processed agricultural sectors, both the high-value good and the non-food good expand production, mostly for exports. The high-value processed good increases production while the high-value primary product stays about the same; thus an increasing share of the primary good is used as an intermediate good to the processed good, at the expense of final consumption. In the urban area, devaluation hurts the non-tradables: namely, the construction and services sectors, which account for over half of national output in the base.

The increased demand for exportable agriculture leads to an increase in agricultural wages in all regions and an increase in the value of both types of land across regions. However, because rural households receive (declining) non-agricultural wages as well, they do not necessarily reap significant benefits from the devaluation. In fact, all of the poor rural households are hurt by the devaluation, because they receive such large shares of off-farm income. For similar reasons,the rural rich of the Southwest region experience a slight decline in their factor income (about four-tenths of a percent). The clear winners are the rich households in the North and Central regions, who derive much of their income from land earnings, and experience factor income increases of over 10%. In the urban region, only blue-collar labor wages and capital rents rise, so on net, urban households see incomes decline.

ii. Labor Migration

The devaluation experiment was also performed allowing labor mobility. As discussed in Section IV, agricultural labor is assumed to migrate to the unskilled labor market in the urban area, and unskilled laborers can migrate back to the rural regions, working in agriculture. The decision to migrate is based on the wage differential between the rural region's agricultural wage and the unskilled urban wage. This differential carries a "threshold" to reflect the fact that workers will not migrate if there is a small change in the wage differential, but only after a certain bound on the differential is exceeded. Because agricultural wages increase during the devaluation, and unskilled wages decrease, the devaluation can cause "reverse" migration - ie., workers will moved from urban to rural areas. Indeed, as Graph 1 shows, a 5% devaluation is sufficient to induce unskilled laborers to move to the rural regions.

Graph 1:



Note: Positive migration shows migrants coming into the labor market. Negative migration shows migrants leaving the labor market. See Table 2 for explanation of abbreviations.

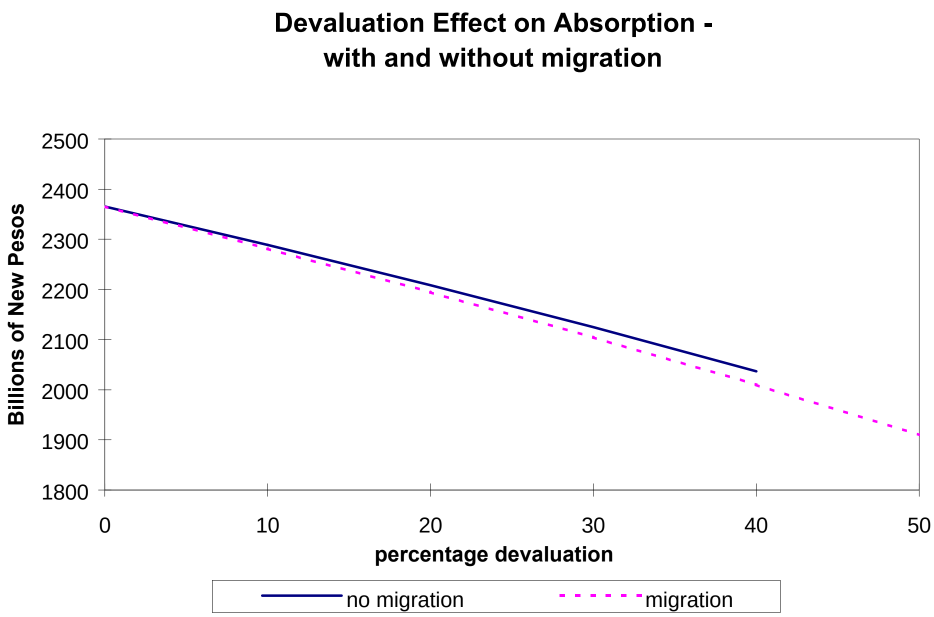
As a result of migration, the increase in agricultural wages which occurred without migration is dampened somewhat, as is the decrease in unskilled wages. With this increase in labor supply, the decline in production of the low-value crop is tempered and the other two crops experience noticeable increases.

Of the urban factors, the unskilled labor wage improves compared to the non-migration scenario (though it is still lower than before the devaluation), since there is a net outflow of workers. The other factors, including capital, see slight declines in their payments. This result is due to the somewhat greater contraction of urban production sectors when resources are able to shift to the exportable, mostly rural, goods. Poor and medium urban households, who derive a large portion of income from unskilled labor, have a slight improvement in earning over the non-migration scenario. On the other hand, rural urban households, who receive almost no income from unskilled labor, lose income.

The only rural household that suffers from migration is the medium household in the North. This is due to the fact that dry land returns fall there, since the greater increase in the production of the high-value and non-food crops decreases the demand for dry land. All other rural households are better off in the face of migration; although the poor do receive lower agricultural wages, they benefit more from the higher returns to land as well as from the increase in unskilled labor returns. Rich households, particularly in the North and Central regions, reap the largest gains, since they receive all of the (even greater) returns to irrigated land, whose value increases the most with the influx of extra workers.

As Graph 2 shows, absorption falls slightly more, due to the increase in the share of domestic production destined for the exports market. However, generally, migration does not significantly change any of the macro accounts.[12]

Graph 2:



[12]The devaluation experiment with migration is carried out under an additional two scenarios for sensitivity analysis. In one, the devaluation was limited to 3% intervals, for a total of a 15% devaluation in five steps. In this case, migration still occurs to all regions, but in smaller numbers. Secondly, the migration tolerance bound was changed. When it is raised to +/-0.10, suggesting that the wage differential must change by 10% to induce migration, no one migrates until the fourth 5% devaluation, and only to the North, Southwest and Southeast regions. On the other hand, when it is reduced to +/- 0.005, all regions begin to send migrants within the first 5% devaluation.

B. Productivity Shock

i. Without Labor Migration

In the second set of experiments, productivity is improved for all crops in the North region. This is done by increasing the shift parameter in the production function for those sectors, in 20% increments, five times. This productivity enhancement leads to large increases in the crops of the North; the high-value and low-value crops expand by about 20% and the non-food crop expands by about 22% after the first 20% increment. After the fifth increment, the high-value, low-value and non-food crops have expanded by 102%, 95% and 114% respectively. Correspondingly, the prices of the goods fall, from around a 5% decline each after the first 20% change in productivity, and continue falling by over 16% of their base prices by the end of the experiment series. Because all factors are regionally immobile, total regional production in the other regions cannot change very much. However, the composition of output can and does: each region responds by contracting its production of the good whose price falls the most in the North - namely, the low-value crop - and shifts its resources into the other two goods. Each region ultimately produces slightly less as a consequence. The net national result is an increase in production of all goods: the national supply of the high-value good increases by 32%, of the low-value good increases by 17% and of the non-food good by 24%.

The urban region benefits from the increase (and lower price) of the raw commodity for the processed food sector. In particular, production of the high-value processed good increases by 3% and of the low-value processed good by 2.6%. The increase of the raw non-food good is destined mainly for exports rather than as an intermediate good. Indeed all three raw goods experience a large increase in exports. There are slight increases for the services and transportation sectors, taking resources away from light manufacturing, capital goods, consumer goods, and intermediate goods. On net, this shuffling of resources leads to a slight fall in urban production.

The wage changes come directly from the changes in output. Agricultural laborers in the North see their wages increase nearly 12% from the first productivity shock, and by the end of the series their wages have risen 53% from the base. Their peers in other regions are not so lucky, however: the slight decline in regional production causes a small decrease in agricultural wages, ranging from 1.5 to 1.8%. All land in the North region benefits from the increased production. All land in the other areas loses value, with the exception of Southwest irrigated land, which benefits from shifting its resources into the non-food production. Urban factors of production see only slight changes (with an absolute difference of no more than 0.5%), since net production falls only a small amount.

Overall, the economy is better off after the productivity increase. Total absorption and consumption increase in real terms. In terms of income distribution, the households in the North see the biggest increase in income, particularly the rich households, who derive much of their income from returns to irrigated land. All households in the Central and Southwest region are hurt by the decline in agricultural wages and returns to land. Households in the

Southeast see very slight increases in their incomes, since these households have the most diversified incomes. Similarly, all urban households see almost no change in their incomes, because of the small changes in urban wages.

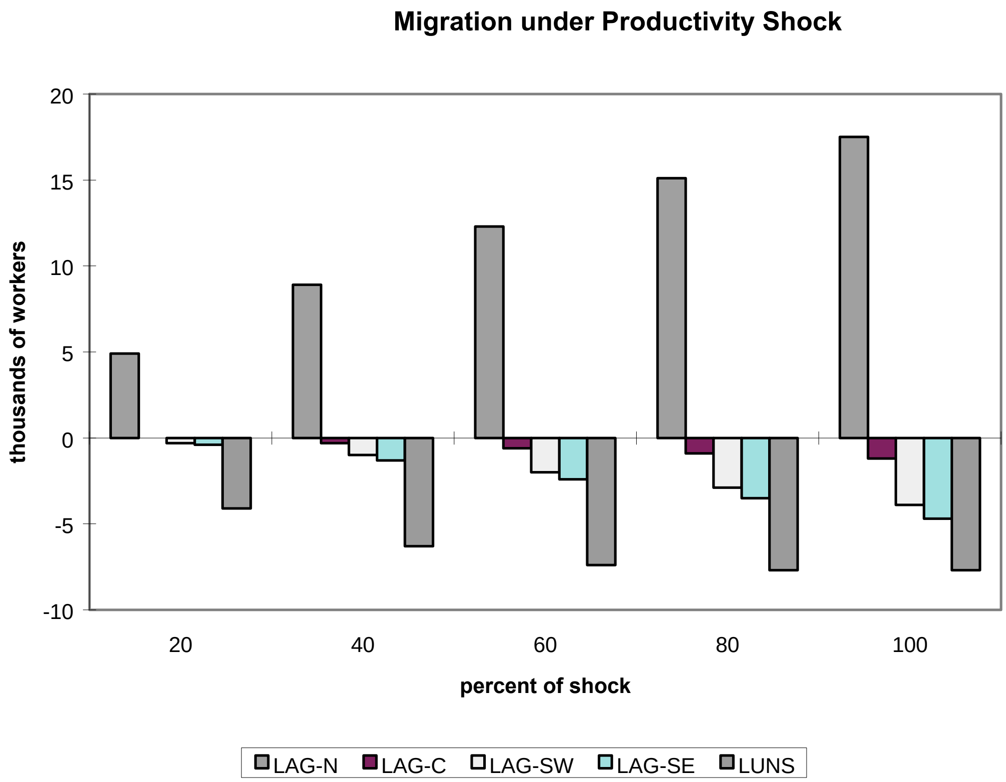
ii. Labor Migration

When the productivity shock experiment is performed under the assumption of labor migration, the effects are dampened across the regions. Migration brings about opposing factors in the unskilled labor market: on the one hand, increased production in the North causes the wage gap between unskilled laborers and agricultural laborers in the North to fall. As a result, unskilled urban workers migrate to the North region, lowering the labor supply to the unskilled urban labor market. At the same time, the increased supply of the high-value primary product means that more of the high-value processed good will be produced, which increases the demand for unskilled urban labor. These two forces put upward pressure on the unskilled labor wage, thereby increasing the gap with the agricultural wage in the other regions. This then leads to an *outward* migration of agricultural workers in the other regions toward the unskilled urban labor market.

As Graph 3 shows, unskilled workers begin migrating to the agricultural labor market in the North after a 20% increase in productivity, and agricultural workers from the Southwest and Southeast areas move to the urban unskilled labor market. After the second shock, agricultural workers from the Central region also begin migrating to the unskilled urban labor market.

When labor migration is permitted, the North region is no longer constrained by a limited labor force, and output from the North increases by even more than in the previous simulation, and prices of those crops fall more. The other regions, now losing agricultural labor, cannot produce as much as they did without migration, and all of their crops experience lower output. All of the urban sectors see a slight decline in output from the situation of no migration, including the processed goods sectors, since more of the raw good is destined to exports. Activities which require the most intensive use of unskilled workers (light manufacturing and services, in particular) experience slight declines in output because there is a net decrease in the number of unskilled workers now available due to the migration North.

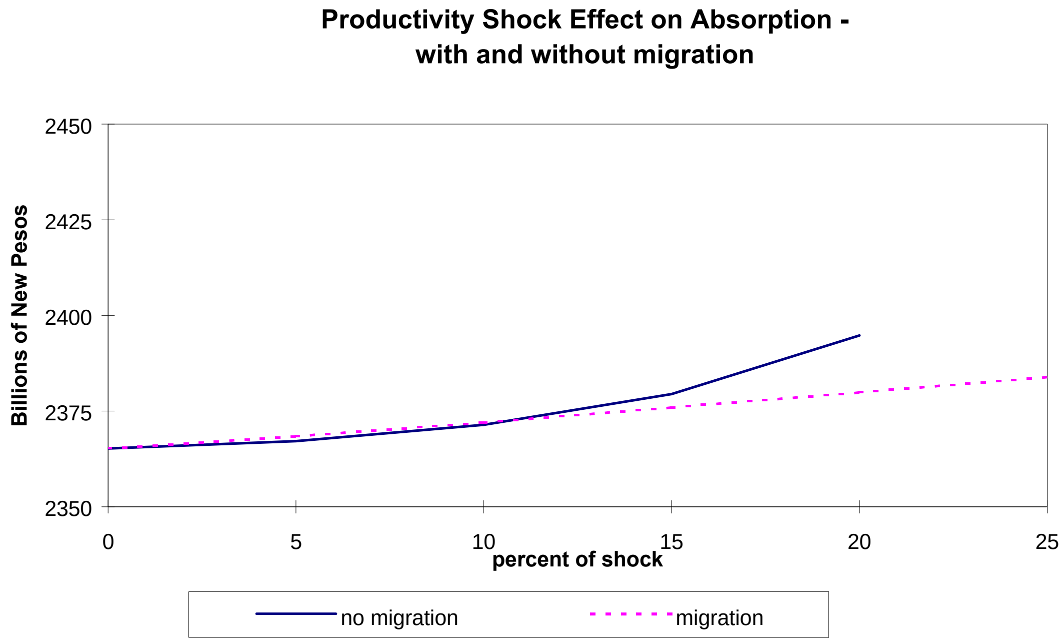
Graph 3:



Positive migration shows migrants coming into the labor market. Negative migration shows migrants leaving the labor market. See Table 2 for explanation of abbreviations.

In terms of income distribution, rich households in the North see their incomes rise with the productivity shock, but for the poor and medium households, this rise is less than when there was no migration. With the influx of workers, the increase in the agricultural wage in the North is dampened. However, rich households have larger gains because they are the primary owners of irrigated land, whose value increases even more with the additional laborers. In the other rural regions, poor households see improvements in income, due to both the dampened fall in their agricultural wages and the increase in unskilled labor wages. The medium households see very small changes in income; they benefit from the increase in unskilled wages, but suffer from the declines in returns to land. The other rural rich households see slight declines in their incomes, because of the declines to returns to land. In the urban region, all households are better off than they were before the productivity shock, since the unskilled wage has increased. As in the devaluation experiment, migration does change some of the structure of the economy, but does not greatly impact the macro accounts, as seen in Graph 4.

Graph 4:



VI. Conclusions and Further Work

This paper has demonstrated the importance of using a regional model to see the effects of both national and region-specific changes in a country. By using a mixed-complementarity approach, the model allows for regime changes and threshold effects in migration. With or without migration, the simulations demonstrate that no one region is fully isolated from national changes, but the effects are different across regions. Similarly, shocks which directly affect only one region will have indirect impacts on other areas.

The experiments show that while integrating into national markets via labor market participation may cushion rural households during agricultural downturns, when the national economy suffers, rural households will, to some extent, share in the suffering as well. Internal migration does help to spread the benefits of external changes, such as a productivity increase in the North, by increasing wages in the labor market which provides the migrants. At the same time, migration concentrates production into one sector which therefore concentrates the benefits to a small group of households, in this case the rural rich. Similarly, in the case of a negative macro shock such as a devaluation, migration can help spread the income benefits across rural and urban regions, though again, the rural rich reap the biggest gains.

The model will be further enriched with the addition of transportation and marketing margins by regions, which can be added into the mixed-complementarity specification to see how changes in the costs of bringing goods to national market can affect regional output and income. In addition, the model would benefit from more detailed information on migration data, in terms of receiving and spending remittances, to capture more effectively the multiplier effects of migration.

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