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Are Incomes Converging along the US-Mexico Border?
(2nd Iteration)

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Abstract: Income convergence of US counties and Mexican municipalities on the US-Mexico border is examined over the period from 1970-1999. Adjusted US data from the Regional Economic Information System is combined with estimates of Mexican municipal output to form a sample for the entire border region. Mexican municipal output estimates are derived from the Mexican census data of sectoral employment and population counts, along with estimates of state-level output by sector. Purchasing power parity values are obtained from conversion factors in the Penn World Tables, Version 6.1. All data is in constant 1996 US dollars. Weak alpha convergence holds in the second period (1985-1999) for productivity levels but not for income per capita. All periods exhibit weak beta-convergence and relatively strong conditional beta-convergence. The reform period of Mexican policy (1985-99) is associated with relatively faster rates of conditional convergence.

JEL classification: F15, F43
Keywords: convergence, economic growth, integration

Introduction: Why convergence matters

It is not hard to argue that United States-Mexico integration is most intense in the border region. Migratory flows of labor, cross-border retail trade and tourism, transportation and distribution activities, growth of the maquiladora sector, dollarization in northern Mexico, and a number of other forces connect the two sides of the border region. The extent of economic and social integration naturally raises questions about income differences, and, specifically, whether the pull of integration has eliminated some of the differences observed in average Mexico-US comparisons.

One of the curious features of the border region is that Mexican and US sides play opposite roles with respect to their national averages. That is, while Mexican incomes in the border region tend to be higher than average in Mexico, US incomes are among the lowest in the US. Consequently, the ratio of border-US to border-Mexico is well below the ratio of average-US to average-Mexico.

As notable as this feature of border incomes might be, it begs the question of income convergence. Granted that the US side is below the US average and the Mexican side is above the Mexican average, it remains an open question whether integration in the border region is leading to a reduction in income differences over time. The is an important question because one interpretation of income divergence is that further deepening of the US-Mexico economic relationship might not have any effect in reducing average income differences at the national level. Under those circumstances, it is reasonable to believe that economic, political, and social conflict connected to migration issues, the lack of social trust between the two nations, and differential enforcement of regulatory systems, among others, may persist for a much longer period of time.

This paper examines the extent of economic convergence in regional product along the US-Mexico border. It develops a methodology for estimating gross product at the municipal level in Mexico and uses the results to test for income convergence among the US counties and Mexican *municipios* contiguous to the border. In general, the results show extremely weak convergence of incomes over the long run from 1970 to 1999.

The next section defines convergence and the one following provides a brief overview of the convergence literature. This is followed by a discussion of the methodology used to construct the regional product of Mexico's border municipios and a final section discusses the results of the statistical analysis.

Convergence

Convergence of incomes is implicit in most neoclassical models of economic growth. With the exception of endogenous growth models, neoclassical models assume diminishing marginal returns to each factor when the other factors are held constant. That is, holding labor constant, increases in the amount of capital cause output to rise at a decreasing rate. Factor income depends on its marginal product so that investors find higher returns in capital scarce regions. This leads to a flow of capital from high to low income areas, and ultimately, a convergence in income levels.

The meaning of convergence still has several possibilities, however (Baumol, Nelson, and Wolff, 1994). Generally, definitions fall into two main categories, called alpha (α) and beta (β) convergence. The first type, α-convergence, is a decline over time in the dispersion of incomes. Dispersion is typically measured with the standard deviation or coefficient of variation. The second type of convergence, β-convergence, has two distinct meanings in the empirical literature. First, and like α-convergence, β-

convergence may refer to absolute convergence in income levels. This is possible only if poor regions grow faster than rich ones, and it implies α-convergence. Tests for absolute β-convergence are of the form:

(1) $$(1/T)ln(Y_{rT}/Y_{r0}) = \beta_0 + \beta_1 ln(Y_{r0}),$$

where the left-hand side is the average annual growth rate of income in region r from year 0 to year T, and the test for convergence is $\beta_1 < 0$. That is, the lower the initial level of income, the higher the growth rate, or, poor regions grow faster than rich ones, and as a consequence, incomes inevitably converge.

An alternative type of β-convergence is called conditional β-convergence. Conditional convergence recognizes that different countries may have different steady states so that at any given level of capital per worker, the marginal product will differ between countries. Tests for conditional β-convergence attempt to hold constant the steady state by adding variables to equation (1), such as the investment to GDP ratio, population growth, or a measure of education levels. The specification of the test for convergence changes from a version of Equation (1) to

(2) $$(1/T)ln(Y_{rT}/Y_{r0}) = \beta_0 + \beta_1 Y_{r0} + \beta X,$$

where X is a vector of variables that controls for the steady state, and β is a coefficient vector. Again, the test for convergence is a test that $\beta_1 < 0$.

In most empirical studies, a more rigorous interpretation of the criteria for β-convergence, either conditional or absolute, is developed from micro-foundations of utility maximization. Barro and Sala-i-Martin (1992) provide a clear exposition along these lines. The appropriate version of equation (1) becomes

(3) $$(1/T)ln(Y_{rT}/Y_{r0}) = \beta_0 + [(1-e^{-\beta T})/T]ln(Y_{r0}),$$

where β is the rate of convergence.

Convergence Studies

Convergence studies of state level data in the United States have consistently found α and β convergence for most of the periods in which it is possible to measure state incomes. For example, Barro and Sala-i-Martin (1991, 1992) and Sala-i-Martin (1996) show that both types of absolute convergence have occurred from 1840 through 1980, with the rate of β-convergence estimated to be around 2 percent per year. For unexplained reasons, convergence apparently ended in the US in 1980. Several potential causal factors have been cited by the literature, including an end to regional price convergence, the non-uniform distribution of high tech investment, and the possibility that states ultimately reached their individual long run growth rates (Bernat, 2001). In a somewhat different context and using an endogenous growth model, Easterly (2001) raises the possibility that endogenous state or regional sorting can cause income levels to vary more or less permanently. Easterly's position is similar the "convergence club" hypothesis and "contagion effects" described below.

For Mexico, Diaz-Bautista (1999) finds β convergence at the rate of 3.1 percent per year in product per capita across Mexico's 31 states during the period 1970-1985. Between 1985 and 1993, during the period of rapid liberalization in Mexico's economic policies, Diaz Bautista shows that Mexican state incomes have diverged, albeit not significantly, even after controlling for inter-state human capital differences.

At world levels, the empirical literature has usually rejected the idea of absolute convergence in income, although recent analysis using population weighted data challenges this finding (Sala-i-Martin, 1996, 2002; Capolupo, 1998; Cho, 1994, 1996; Quah, 1996, Barro, 1991).

The apparent fact that poorer countries tend to grow slower, not faster, than rich countries seemed initially to argue against neoclassical growth models of the Solow type, since diminishing marginal returns to capital in high income regions appears to have little impact on growth or the redirecting of investment to low income, capital scarce, areas. Given that steady states may vary across countries, countries may converge to their own unique level of income, after which growth is determined by the rate of technological change, minus depreciation and the population growth rate. Hence, the empirical literature tries to control for the steady state level of income in each country by employing a proxy variable such as investment to GDP ratio, a measure of secondary education, or the growth rate of the population. Controlling for these variables usually results in the finding of conditional convergence among countries, often at the rate of 2 percent (Barro and Sala-i-Martin, 1992; Sala-i-Martin, 1996).

The finding of conditional convergence has not gone unchallenged. Cho (1994, 1996) and Easterly (2001) argue that the control variables used to hold constant the steady state level of income are endogenous to the level of income. Cho argues that once the simultaneity bias is eliminated, conditional convergence does not hold. Quah (1996) and others have proposed the idea of “convergence clubs” which are groups of relatively homogenous countries that show intra-group convergence. Baumol (1994) proposes an explanation for convergence clubs based on “contagion and common forces.” In his model, external disturbances start a growth process in one region or country which infects other areas through market mechanisms, technology leakages and transfers, imitation, and factor migration.

Methodology for estimating income on the US-Mexico border

The US Department of Commerce's Regional Economic Information System (REIS) provides estimates of personal income at the state, country, and MSA level (Department of Commerce, 2002). Since Mexican data is presented on a GDP basis, US data must be adjusted to make it comparable in economic accounting terms. Personal income in US border counties is adjusted upward by the ratio of GDP to personal income at the national level. The US CPI is then used to convert the data to 1996 dollars. Income is then measured in per capita or per worker terms, depending on the series.

The income (product) of Mexican municipalities contiguous with the border are less straightforward to estimate for several reasons.[1] First Mexico's national statistical agency, Instituto Nacional de Estadística, Geografía, e Informática (INEGI), does not calculate income levels below the state level. Second, the state level data is only available for selected years (1970, 1980, 1985, and annually 1993-1999). Third, all income measures are in pesos which must be converted to an equivalent dollar measure. The remainder of this section describes the method used to obtain constant dollar, purchasing power parity estimates of product per capita and product per worker for the municipalities along the border.

Estimates of gross municipal product (GMP) are for 1970, 1980, 1985, 1993, and 1999, a subset of the years for which there are official estimates of state product (gross state product, or GSP). Official estimates of GSP for 1970 and 1980 provide data points

[1] Mexican municipios include both rural and urban spaces and are geographical units similar to US counties.

for the decade prior to the onset of the debt crisis in 1982. In addition, they are coincident with Mexico's decennial censuses of population and housing, which contain useful employment data and are used to estimate municipal level product, as explained below. The third data point, 1985, comes in the immediate aftermath of the debt crisis and provides a useful view of the changes in Mexico. The following year, 1986, Mexico began its historic shift away from inward-looking import substitution policies. In 1986, Mexico joined the GATT and soon thereafter the OECD, followed by the opening of NAFTA negotiations, waves of privatizations in airlines, banking, and many other industries, ejido reforms, and other market-oriented reforms. Consequently, 1985 to 1993 is a useful period for looking at the impact of reforms on income convergence along the border. Finally, the period 1993 to 1999 gives a snapshot of the impacts, if any, of NAFTA and closer ties to the US.

Gross State Product (GSP) for the six Mexican border states comes from INEGI (2002) and includes the years 1970, 1980, 1985, 1993, and 1999. State data are disaggregated into municipal shares based on each sector's share of GSP and each municipality's share of state employment in each sector. Let Y_m equal municipality m's total income, Y_s equal state s's total income, e_{im} is sector i's employment in municipality m and e_{is} is total state employment is sector i and state s. Then

(4) $$Y_m = \lambda Y_s, \text{ where } 0 < \lambda < 1, \text{ and}$$

(5) $$\lambda = \sum_i (Y_{is}/Y_s)(e_{im}/e_{is}).$$

Equation (5) states that municipality m's share of state income is equal to the sum of the products of state-level sectoral income shares times municipal-level employment shares. There are nine sectors and Equation (5) assumes the same productivity within a given sector and across the municipalities of a given state. For example, agriculture in each of the border municipalities in the state of Chihuahua is assumed to have the same output share of total state agricultural output as its employment share. This probably biases upward rural incomes, and biases downward urban ones since productivity within a sector is likely to be greater in urban areas than in rural. This issue is examined in the estimations of the next section.

Conversion from current pesos to constant 1996 dollars at purchasing power exchange rates is accomplished using the series RGDPCH (chained real international dollars) from the Penn World Table, version 6.1 (Heson, Summers, and Aten, 2002). State incomes, taken from the INEGI source, are converted to purchasing power parity dollars using the RGDPCH series. Municipal incomes are then calculated as λ times the state income.

[Figure 1 and 2]

Figures 1 and 2 show estimates of the ratio of average US/Mexican border incomes per person and output or income per worker. The ratios in Figures 1 and 2 are:

(Average US border county income)/(Average Mexican border municipality income).

Note that the ratio of US/Mexican output per worker is smaller than ratio of output per person, implying that the border productivity gap is smaller than the border income gap. In addition, there is divergence in average incomes between 1970 and 1980 or 1985, followed by a relatively constant ratio thereafter. Over the entire time period, Mexican municipalities experienced a growing share of its population in the labor force so that between 1970 and 1999, the ratio of population to workers in the Mexican sample fell from 3.7 to 2.9, increasing output per person beyond the effect of the rising productivity.

Finally, the population weighted averages are somewhat higher, although more so in the US than in Mexico. This reflects the fact that incomes are higher in urban counties than in rural, particularly in the US.

Convergence along the US-Mexico border?

Figures 3 and 4 show the coefficient of variation measure of α-convergence in output per worker and output per person. The sample is presented three ways, for US border counties only, for Mexican municipalities only, and for the combined sample. For the Mexican municipalities alone, both Figures 3 and 4 show α-convergence between 1970 and 1993, with neither divergence nor convergence thereafter. Note that between 1970 and 1980 there is divergence, however, so that strong convergence between 1970 and 1993 is mainly from 1980 onwards and most notably between 1980 and 1985, the years of the debt crisis.

[Figures 3 and 4]

In the US sample, there is weak convergence of border counties up until 1993 and very little movement thereafter. Overall, the combined US and Mexican sample shows very little movement during the entire period. In other words, according to the α-convergence definition of convergence, there is little evidence to support any particular hypothesis of divergence or convergence.

Tables 1 and 2, speak to the issue of β-convergence. The period 1970-1999 is divided into two subsets, 1970-1985 and 1985-1999. In conjunction with the earlier comments about economic policy reform in Mexico, we can call these periods pre-reform and post-reform. The top third of Tables 1 and 2 show the estimates of β for 1970-85, estimated in three different ways for the combined US-Mexican sample. Also included are separate regressions for the US and Mexican sub-samples. The middle third of the table covers the period from 1985 to 1999, and the bottom third covers the whole period from 1970 to 1999. Table 1 shows data for income per person which Table 2 measures convergence in productivity (income per worker).

The results show statistically significant convergence among the border regions in all time periods and all specifications. In addition, both the US counties alone, and the Mexican municipalities alone exhibited strong convergence. Absolute convergence is very weak, however, as shown in model number 3. At around 0.7 percent per year, elimination of half the difference will take over 100years. In other words, absolute convergence is so weak that it is not a very important economic factor.

Models 4 and 5 show estimations of conditional β-convergence, and in these cases, the rate of convergence is 2 to 3 times faster (-0.015 to -0.031). Conditional convergence is estimated using a simple measure of economic structure, the percent of the labor force in manufacturing and agriculture at the start of the period. Since this variable is at the period start, it cannot be endogenous to the subsequent rate of growth. This approach follows the arguments made by Cho (1994, 1996), Nakamura (2001), and Barro and Sala-i-Martin (1992), among others, who state that convergence estimates should take into consideration changes in the structure of the economies analyzed. Sectors that do well nationally are likely to grow faster locally, and a concentration of productive activity in those sectors give regions a clear advantage. Additionally, controlling for sectoral composition helps to minimize the intertemporal variation across regions resulting from random disturbances at the national level.

As shown in Tables 1 and 2, conditional convergence is relatively strong. The implication is that the different counties and municipalities have different long run steady states, and that it is incorrect to assume that capital flows from high income to low income regions will eventually equalize incomes. Given the economic differences between the geographical units, this should not be too surprising. Some of the regions are highly urbanized, many others are small rural locales, some have enormous manufacturing sectors, others are transportation hubs, and several are primarily agricultural or commercial centers.

Conclusion

Mexico-US linkages in the border region constitute a vast network of economic, social, and political ties. These networks provide a transmission mechanism through which disturbances to one side are quickly transferred to the other. For example, Prock (1983), Patrick and Renforth (1996), and Gerber and Patrick (1996) show how changes in the value of the peso are quickly translated into changes in retail sales in US border communities. Orrenius, et. al., (2001) discuss the enormous growth in trade and the cross-border pressures this puts on trucking and distribution facilities in the border region. Gerber and Rey (1998) show the employment effects on the US side from the increase in the flow of goods, and Hanson (2001) shows how growth in the maquiladora sector affects sectoral employment patterns. Researchers at San Diego Dialogue (1994) and San Diego Dialogue, et. al., (1998) demonstrate the network of social, family, and economic ties that cause people to cross the border. INEGI (2002) estimates that 2-8% of the labor force in some Mexican border cities cross to work in the United States. Given the dense network of cross-border ties, it is not surprising that income convergence occurs along the border.

An increasingly recognized view, and one supported by this work, is that NAFTA supports the integration we observe, but it is not the cause. Gruben (2001), for example, shows that NAFTA is not responsible for the increase in the growth rate of the maquiladora industry, and Burfisher, Robinson, and Thierfelder (2001) show that NAFTA caused an up tick in an already accelerating trade relationship. The results in this paper are ambiguous with respect to both NAFTA and Mexico's economic opening. It does not appear that there is an acceleration after 1985, although there is evidence in the raw data (Tables 1 and 2) of a cessation of a widening income gap

An unanswered puzzle concerns the root causes not of convergence, but of the failure of the US side to participate more fully in prosperity. In other words, why haven't the gains from trade been more apparent in US border counties. This question concerns not just rates of change, but absolute levels as well. Part of the reason for low incomes along the US border—and incomes that are deteriorating in a relative sense (Table 2)—lies within the realm of education and skills. Fullerton (2001) and Gerber (2001) show a large negative effect on regional income levels of significantly lower schooling levels. In addition, dependency ratios are higher and English acquisition is lower (Gerber, 2001). Still, as Easterly (2001) shows, a greater supply of education may not solve problems if the demand side incentives are lacking or if investment in education is complementary and only pays off if many people simultaneously invest.

Could rapidly growing municipios on the Mexican side pass the income levels of stagnant US counties? In purchasing power parity terms, at least, it has already happened. This does not appear to be a distributional consequence of convergence (Table 5), but it is a serious problem along the border.

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Tables and Figures

Figure 1. Ratio of average US/Mexican border income, per person and per worker

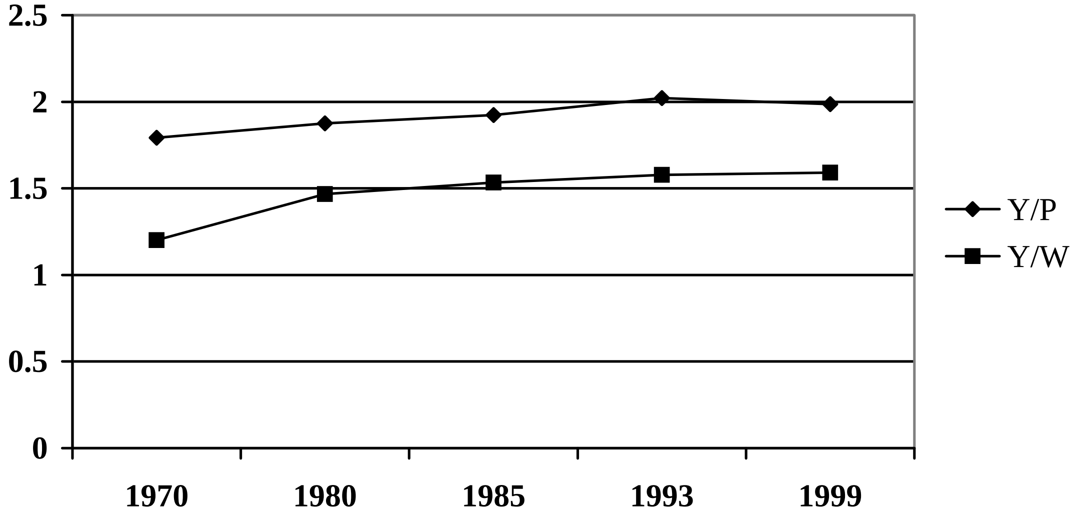

Figure 2. Ratio of average US/Mexican border income, per person and per worker, weighted

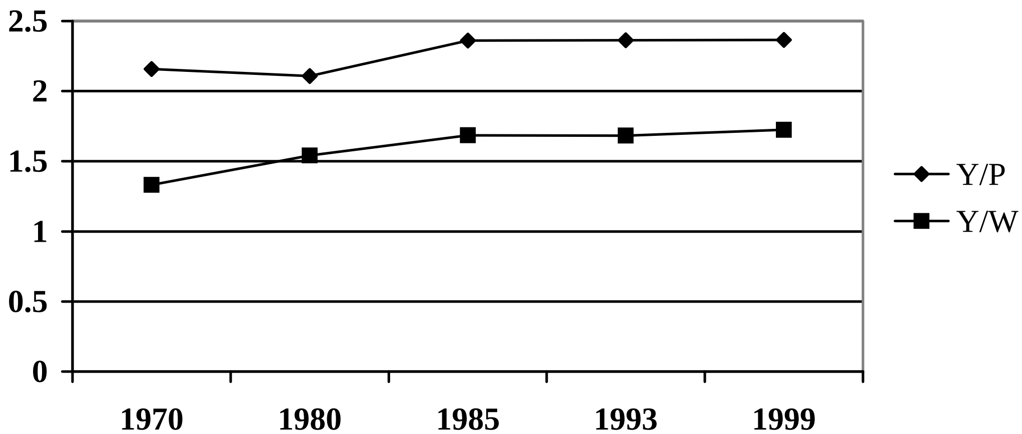

Figure 3. Income per person

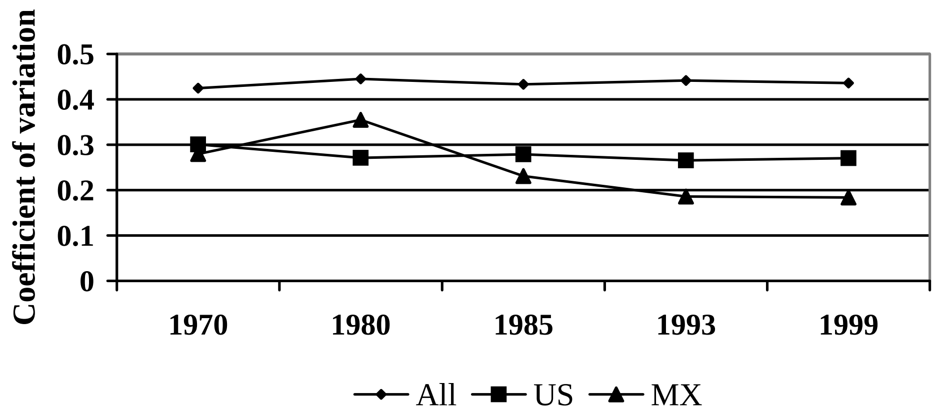

Figure 4. Output per worker

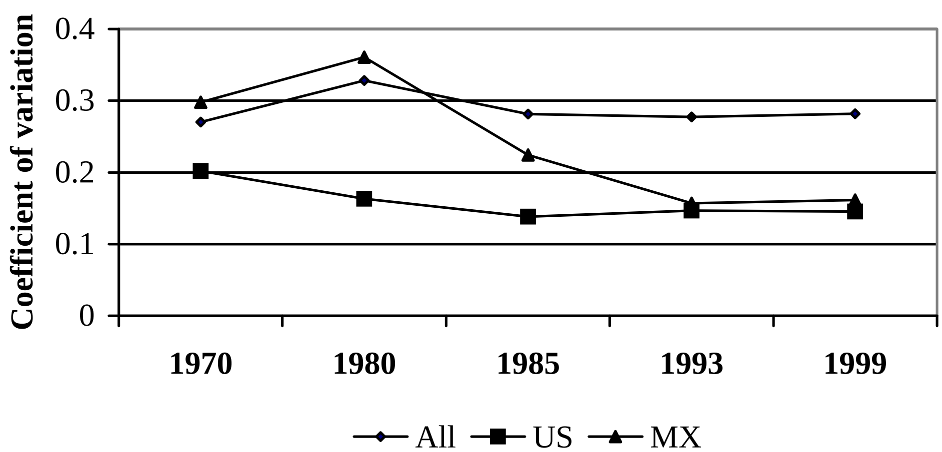

Table 1
β-convergence, US-Mexico border region, 1970-99
Income per capita

	US sample only (1)	*Mexican sample only (2)*	*Combined sample (3)*	*Combined sample (4)*	*Combined sample (5)*
			1970-85		
β	-0.012 (-2.99)	-0.028 (-6.67)	-0.009 (-2.77)	-0.021 (-6.62)	-0.031 (-6.10)
Dummy, US = 1				0.018 (5.03)	
Manufacturing					-0.118 (-5.07)
Agriculture					-0.034 (-3.69)
Number of obs.	26	38	64	64	64
			1985-99		
β (t)	-0.161 (-2.38)	-0.030 (-5.75)	-0.007 (-2.17)	-0.022 (-5.62)	-0.025 (-4.35)
Dummy, US = 1				0.018 (4.30)	
Manufacturing					-0.022 (-1.30)
Agriculture					-0.0252 (-2.48)
Number of obs.	26	38	64	64	64
			1970-99		
β	-0.010 (-4.40)	-0.020 (-10.82)	-0.007 (-3.65)	-0.016 (-10.01)	-0.015 (-7.155)
Dummy, US = 1				0.015 (7.06)	
Manufacturing					-0.069 (-4.66)
Agriculture					-0.025 (-4.29)
Number of obs.	26	38	64	64	64

Table 2
β-convergence, US-Mexico border region, 1970-99
Productivity (Output per worker)

	US sample only (1)	*Mexican sample only (2)*	*Combined sample (3)*	*Combined sample (4)*	*Combined sample (5)*
			1970-85		
β	-0.032 (-6.68)	-0.030 (-8.25)	-0.021 (-4.43)	-0.030 (-10.70)	xx
Dummy, US = 1				0.024 (8.99)	
Manufacturing					-0.216 (-1.30)
Agriculture					-0.025 (-2.47)
Number of obs.	26	38	64	64	64
			1985-99		
β (t)	-0.294 (-3.38)	-0.035 (-7.10)	-0.014 (-3.17)	-0.034 (-7.97)	-0.025 (-4.35)
Dummy, US = 1				0.021 (5.37)	
Manufacturing					-0.022 (-1.30)
Agriculture					-0.025 (-2.47)
Number of obs.	26	38	64	64	64
			1970-99		
β	-0.017 (-6.62)	-0.022 (-14.10)	-0.015 (-6.38)	-0.021 (-15.90)	-0.025 (-12.49)
Dummy, US = 1				0.015 (10.74)	
Manufacturing					-0.067 (-5.67)
Agriculture					-0.032 (-6.79)
Number of obs.	26	38	64	64	64