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Modeling Personal Transfers from the United States

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Modeling Personal Transfers from the United States

By Rachel Soloveichik and Anne Flatness

Abstract

The Bureau of Economic Analysis (BEA) estimates remittances using a demographic model. BEA's model combines detailed data on immigrants from the American Community Survey with remittance rates by demographic category. In this paper, we use newly released data from the Current Population Survey (CPS) to revise the demographic variables and associated remittance rates in BEA's model. The revised model has already been incorporated into BEA's international transactions accounts for 2009 forward.

We begin by testing BEA's previous model against the remittance data reported in the CPS. We show that the demographic factors in BEA's previous model are weak predictors of remittances. We then outline stronger predictors that are used in the revised model. The new demographic variables are: married (spouse absent) and the presence of roommates. We also introduce a new procedure for assigning remittance rates by birth country. The new procedure uses U.S. immigration law and government policy in the birth country. These revisions quadruple the adjusted R^2 of BEA's model. As a robustness check, we test our revised model against two alternative datasets: the New Immigrant Survey and the World Bank's remittance statistics. We find the revised model to be a better match for both of these alternative datasets.

The revised model predicts a 6% drop in remittances in 2009 – twice as large as the drop in remittances predicted by BEA's previous model. The larger drop is mainly caused by a decrease in the population of migrants who are married (spouse absent) and a decrease in the average income of immigrants who are living with roommates. In the revised model, these immigrants remit more than average, so changes in their population and income have a substantial impact on remittances.

Introduction

Personal transfers in the U.S. international transactions accounts (ITAs) consist of all current transfers in cash or in kind sent or received by resident households to or from nonresident households.[1] These transfers, which are also referred to as 'remittances,' are a component of "private remittances and other transfers" in the standard presentation of the ITAs.[2]

Personal transfers are one of the hardest items to calculate in the ITAs. Virtually all personal transfers are small and fall below financial reporting thresholds. In addition, many transactions are in cash or sent through informal channels where there is no paper trail. Throughout the world, countries use a variety of methods to estimate transfers received and transfers sent. Summing up data from each country, we see that reported transfers received are larger than reported transfers sent. This suggests that some countries are underestimating transfers sent or overestimating transfers received. Because it is difficult to collect data directly, the Bureau of Economic Analysis (BEA) uses an economic model to calculate personal transfers sent from the United States. This model combines information on the population and income of the foreign-born in the United States with remittance rates determined by their demographic characteristics.

In this paper, we introduce revisions to BEA's model based on newly available data from the Current Population Survey (CPS). The revised model maintains the same general structure as BEA's previous model but changes the demographic factors that determine remittance rates. The revised model reports a larger drop in remittances in 2009 than the previous model.

This paper is divided into four sections. Section 1 describes the CPS survey data and BEA's general model. Section 2 uses the new CPS data to test the demographic categories in BEA's previous model. Section 3 outlines changes to these demographic categories to improve the model's fit. We show that the revised demographic categories improve the model's fit to the CPS data. Section 4 compares the prior and revised models with two alternative data sets: the New Immigrant Survey and World Bank remittance statistics. Finally, Appendix A presents additional detail on the statistical methods used to produce the revised model.

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1 See *Balance of Payments and International Investment Position Manual*, 6th ed. (Washington, DC: International Monetary Fund, 2009) for additional information on the statistical definitions of personal transfers and remittances.

2 For annual and quarterly data on "Private Remittances and Other Transfers" see Table 1, line 38 at http://www.bea.gov/iTable/index_ita.cfm.

1. Current Population Survey Data, BEA's General Model, and Methodology

Current Population Survey Data

The primary survey data used in this paper come from the Census Bureau's Current Population Survey (CPS). In August 2008, the Census Bureau added a one-time module on remittances to the monthly CPS survey. This module asked households three questions about money sent abroad:

a) Whether they'd given or sent money to relatives or friends abroad in the past year
b) How many times they'd given or sent money abroad in the past year
c) How much money they'd given or sent abroad in the past year

In this study, we restrict the sample to households with at least one immigrant adult who answered question c.[3] Households without immigrants account for less than 10% of the remittances in the CPS data, so this restriction does not significantly impact the results.[4]

BEA's General Model

BEA's general model uses three main variables to calculate remittances by the foreign-born population to friends and family in their countries of birth:[5]

- The foreign-born population in the United States
- The income of the foreign-born population
- The percentage of income remitted

Data on the foreign-born population and the income of the foreign-born population come from the Census Bureau's annual American Community Survey (ACS). The remittance rates are BEA estimates. The model assumes that remittances are sent to an immigrant's country of birth.

[3] We treat persons from Puerto Rico, as well as Guam and other U.S. territories, as non-immigrants. Under international guidelines, these areas are considered part of the United States' economic territory.
[4] BEA estimates the outward remittances of the native-born population to be a fixed portion of remittances received by U.S. residents. These international transactions are not covered by this paper.
[5] In prior publications, BEA's model was described as having four variables, with the remittance rate divided into a percent of the population that remits and a percent of income remitted for those who remit. For this study, we have collapsed those two into a single remittance rate.

Each of these variables is arrayed according to demographic characteristics. Remittances are a fixed share of income for each demographic category. To calculate personal transfers, BEA multiplies the foreign-born population by the average income by the corresponding remittance rate for each cell in the array. The remittance rates vary according to demographic characteristics. For example:

- Time in the U.S. – Immigrants remit a smaller percentage of their income as they spend more time in the United States.
- Country of birth – Immigrants from geographically close, low-income countries remit a larger percentage of their income than those from geographically far, high-income countries.
- Household structure – Immigrants with close family members in the household remit a smaller percentage of their income.

The relative importance of these and other demographic variables within the general model is the subject of study in this paper. The overall structure of the model (i.e., population * income * remittance rate) remains unchanged.

Evaluating the CPS Data

The CPS remittance module is the first time that the United States has asked questions about remittances on an official, nationally-representative survey. Although some remittance data have been collected on official surveys in the past, notably on the Legalized Population Surveys from the late 1980s and early 1990s and on the New Immigrant Survey from the 2000s, these surveys only collected data on newly legalized immigrants. The CPS, in contrast, collects data on the entire U.S. population regardless of immigration status. The CPS is also particularly useful because it collects similar demographic information to the ACS, the source of the population and income data in BEA's model. Therefore, it is straightforward to calculate annual remittance estimates from the annual population data provided by the ACS using the demographic categories and remittance rates by category from the CPS data.

However, there are some drawbacks to using the CPS data. The data collected on the CPS do not completely conform to the statistical definition of remittances (personal transfers). In the international transactions accounts (ITAs), short-term workers are considered residents of their home country. Because they are not residents of the United States, all income earned by those workers is part of the category "income payments - compensation of employees" (ITA Table 1, line 34). The portion of this income that is spent in the United States is recorded as an export of "other private services" (ITA Table 1, line 10). The CPS does not distinguish between short-term workers and immigrants who plan to stay

in the United States. This may bias the remittance rates if short-term workers remit differently than long-term migrants.

Furthermore, the CPS tracks a slightly different sample population than the ACS, BEA's data source for the income and population of the foreign-born. Unlike the ACS, the CPS is only conducted in English and Spanish, so it may miss some immigrants who do not speak either language. In addition, the CPS remittance module was administered in August 2008, so it might capture a different population if summer residents are not representative of year-round residents. In contrast, the Census Bureau mails the ACS in April and follows up with non-responders in the following months. To get a nationally representative sample, the CPS has produced household weights to adjust the raw data. We will use those weights in our regressions. Even with the weights, the CPS has a lower number of immigrants in some key demographic categories than the ACS. [6]

BEA's model uses individual demographic data from the ACS to predict individual remittances. In contrast, the CPS collects remittance data by household. In order to compare the CPS data with BEA's model, we use demographics, country of origin, and time in the United States to predict individual remittances for each adult in the CPS sample. We then aggregate those individual remittances by household to predict total household remittances. The CPS also does not ask for individual income; instead, it asks for household income. We use age and sex to impute individual income shares based on average earnings for each age and sex. We then multiply that income share by the family income to derive individual incomes. We also use this method to impute incomes for households that do not report income. Results were similar if we imputed individual income by matching immigrants in the CPS with immigrants in the ACS who had the same family structure, time in the U.S., and geographical tier.

Finally, total remittances reported on the CPS are lower than BEA's published estimates. The CPS data were first described in the paper, "Who in the United States Sends and Receives Remittances" (Grieco, et al. 2010). According to that paper, many immigrants were reluctant to report precise financial details about remittances. This calls into question the levels reported in the CPS data. However, this underreporting is not likely to change relative remittances between demographic groups, which are the focus of this paper. To account for the questionable levels, we scale the CPS remittance data so that aggregate remittances for 2008 match BEA's pre-existing aggregates for 2008.

[6] As will be explained later in the paper, being married, spouse absent, and living with roommates increases the remittance rate. The population is 5.3% married, spouse absent in the ACS vs. 3.2% in the CPS, and 7.3% living with roommates in the ACS vs. 4.9% in the CPS.

Methodology

For all of our regressions, we calculate the household remittance rate by dividing reported remittances by reported immigrant income. This removes the impact of income on remittances and allows us to examine demographics alone. This calculation is equivalent to assuming that transfers are a fixed percentage of income. In practice, the CPS data show a strong negative correlation between reported income and reported remittance rates. The negative correlation could suggest that transfers are non-linear with income, and poor people give a higher fraction of their income. However, the negative correlation is also consistent with a simple measurement error story.[7] We use OLS regressions to test the accuracy of BEA's remittance models. OLS regressions will give an unbiased estimate of total remittances, but they may have wider standard errors than alternative econometric techniques.

The remittance numbers reported in the CPS data are not normally distributed. Most immigrant households give little or nothing, and a few households give very large amounts. The high remitting households account for a significant fraction of total remittances. For example, mean remittances drop by 60% if we exclude the 175 households that sent $5,000 or more. The high remitting households have an enormous influence on the coefficients in the OLS regression. However, qualitative results do not change if we exclude those households.

2. Testing BEA's Previous Demographic Factors

To start, we tested whether the previous demographic variables used in BEA's model are reliable predictors of reported remittances in the CPS data. BEA's previous model contained three demographic characteristics: time in the U.S., presence of children in the U.S. household, and country of birth. Time in the U.S. is divided into four categories: '0 to 5 years,' '6 to 15 years,' '16 to 30 years,' '30 plus years.' Predicted remittances decrease as time in the U.S. increases. Presence of children in the U.S. household is divided into two categories: no children in the household and one or more children in the household. Having children in the household reduces predicted remittances. Country of birth is divided into four separate geographic tiers: low, middle, high, and highest. Predicted remittances increase from the low

[7] It would be very difficult to incorporate a non-linear remittance rate into BEA's model. Over the past decade, nominal incomes have increased significantly. With a non-linear remittance rate, we would calculate falling average remittance rates. Alternatively, we could assume that non-linear remittance rates depend on real income. In that case, we would need to pick the correct price deflator for nominal income from 2001 to 2010.

country tier through the highest country tier. Remittance rates for each demographic category are BEA estimates based on academic studies and the Legalized Population Survey.

The country tiers in BEA's previous model were based on wealth and distance from the U.S. The low tier contained wealthy countries like Canada, Germany, and the United Kingdom. The middle tier contained middle-income countries like Poland, Thailand, and Argentina. The high tier contained low-income countries throughout the world. The highest tier contained Latin American countries like Mexico, Haiti, and Honduras, which are low-income and geographically close to the United States. These tiers are based on the idea that immigrants from poorer countries will send a higher share of their income as remittances and immigrants from geographically close countries are relatively poorer, so their families have a greater need for remittances.

As was explained in the prior section, we use an OLS regression to test BEA's prior demographic categories. All of the variables in the model are dummies, so they are 0 or 1. The regression and results are given below:

$$\text{Remittance rate} = \alpha_0+\alpha_1*\text{'No Children'} + \beta_1*\text{'6 to 15 years in U.S.'} + \beta_2*\text{'16 to 30 years in U.S.'} +$$

$$\beta_3*\text{'30 plus years in U.S.'}+\gamma_1*\text{'Middle Tier'} +\gamma_2*\text{'High Tier'} + \gamma_3*\text{'Highest Tier'}+\varepsilon$$

Table 1: Testing BEA's Demographics without Interactions[8]

Variable	Variable description	Coefficient	Standard Error	Statistical Significance
α_1	'No Children' vs. 'Has Children'	0.554%	0.180%	**
β_1	'6 to 15' vs. '0 to 5' years in U.S.	-1.450%	0.364%	**
β_2	'16 to 30' vs. '0 to 5' years in U.S.	-2.283%	0.350%	**
β_3	'30 plus' vs. '0 to 5' years in U.S.	-2.654%	0.347%	**
γ_1	Middle vs. Low Tier Birth Country	0.669%	0.287%	**
γ_2	High vs. Low Tier Birth country	0.712%	0.250%	**
γ_3	Highest vs. Low Tier Birth Country	1.508%	0.234%	**
α_0	Constant Term	2.122%	0.367%	**

Table 1 broadly validates the previous demographics. Consistent with BEA's previous model, immigrants decrease their remittances as time in the U.S. increases. However, the difference between

[8] The results presented above are weighted regression, with the weight determined by the CPS household weight and household income. Coefficients are similar without weights, but standard errors are higher.

'16 to 30 years' and '30 plus years' is relatively small. The results also show that, as the model predicted, individuals without children in the U.S. remit a higher percentage of income. However, the effect is relatively weak compared to birth country or time in the U.S. Finally, Table 1 shows that the country tiers from BEA's previous model are valid predictors of remittances. Migrants from countries in the low tier give less than other immigrants, and migrants from countries in the highest tier give more. However, there appears to be little difference in remittance rates for the middle and high tiers. These results suggest that time in the U.S. categories and the geographic tiers need updating.

Despite the statistical significance of the regression shown in Table 1, the R^2 is only 1.88%. The low R^2 indicates that there is significant room for improving the demographic variables in BEA's model. In Section 3, we will introduce revised demographic variables that better match the CPS data. The revised model has an R^2 of 7.93%.

3. Revisions to BEA's Model

In this section, we introduce five separate changes to the demographic variables in BEA's model:

a) Remove U.S. citizens born abroad of American parents from the remitting population
b) Replace children/no children with married, spouse absent/other marital
c) Add living with roommates/other living arrangements
d) Combine immigrants who have been in the U.S. for '16 to 30 years' and immigrants who have been in the U.S. for '30 plus years' into a single time category, '15 plus years'
e) Reallocate countries within the geographic tiers

In the first section, we will preview our results. The remaining sections will examine each new variable individually and show how the change improves the model's adjusted R^2.

Preview of Results

The new demographic variables are married, spouse absent (MSA) and living with roommates. The new time categories are '0 to 5,' '6 to 15,' and '15 plus.' The new country tiers have the same names as the original country tiers, but many countries have been shifted from one tier to another. As in Table 1, all of the variables in the model are dummies. In total, there are 48 separate remittance rates,

corresponding to the four household structures, three time in U.S. codes, and four country tiers. For the final results, we estimate the equation:

$$\text{Remittances} = (\alpha_0+\alpha_1*\text{'MSA \& Roommates'} +\alpha_2*\text{'MSA \& No Roommates'} +\alpha_3*\text{'Other Marital \& Roommates'})*(1+ \beta_1*\text{'6 to 15 years in U.S.'} + \beta_2*\text{'16 to 30 years in U.S.'} + \beta_3*\text{'30 plus years in U.S.'}) *(1+ \gamma_1*\text{'Middle Tier'} +\gamma_2*\text{'High Tier'} +\gamma_3*\text{'Highest Tier'})*(1+\varepsilon)$$

Table 2: Final Remittance Rates Calibrated to BEA's 2008 Total

Revised Geo Tier	Household Structure	0 to 5	6 to 15	15 plus
Low	Other Marital & No Roommates	1.1%	0.8%	0.5%
Low	Other Marital & Has Roommates	3.9%	2.9%	1.6%
Low	MSA & No Roommates	5.9%	4.5%	2.4%
Low	MSA & Has Roommates	11.2%	8.5%	4.6%
Middle	Other Marital & No Roommates	1.1%	0.8%	0.5%
Middle	Other Marital & Has Roommates	3.9%	2.9%	1.6%
Middle	MSA & No Roommates	5.9%	4.5%	2.4%
Middle	MSA & Has Roommates	11.2%	8.5%	4.6%
High	Other Marital & No Roommates	2.8%	2.1%	1.1%
High	Other Marital & Has Roommates	9.7%	7.4%	3.9%
High	MSA & No Roommates	14.8%	11.2%	6.1%
High	MSA & Has Roommates	28.1%	21.3%	11.5%
Highest	Other Marital & No Roommates	7.2%	5.5%	3.0%
Highest	Other Marital & Has Roommates	25.4%	19.3%	10.5%
Highest	MSA & No Roommates	38.8%	29.4%	16.0%
Highest	MSA & Has Roommates	73.4%	55.7%	30.2%

The remittance rates shown in Table 2 are estimated from the regression shown earlier. Those remittance rates produce an R^2 of 7.93%; quadruple the R^2 of 1.88% from Table 1. The precise estimation techniques used for Table 2 are described in greater detail in Appendix A. The similar remittance rates for 'low' and 'middle' tier countries reflect actual data from the CPS. Future research is needed to study why 'low' and 'middle' tier countries remit so similarly.

The revised model has only one more variable than the previous model. Therefore, the higher R^2 primarily reflects improvements in the predictive power of the explanatory variables. In order to simplify the discussion in the paper, we also estimate a linear regression with the same variables. The

base condition is other marital without roommates, low country tier, and '0 to 5 years in the U.S.' The regression and results are described below:

$$\text{Remittances} = \alpha_0+\alpha_1*\text{'MSA \& Roommates'} +\alpha_2*\text{'MSA \& No Roommates'} +\alpha_3*\text{'Other Marital \& Roommates'} + \beta_1*\text{'6 to 15 years in U.S.'} + \beta_2*\text{'16 to 30 years in U.S.'} + \beta_3*\text{'30 plus years in U.S.'} + \gamma_1*\text{'Middle Tier'} +\gamma_2*\text{'High Tier'} +\gamma_3*\text{'Highest Tier'} +\varepsilon$$

Table 3: Remittance Rates by Country Tiers

Variables	Variable description	Coefficient	Standard Error	Statistical Significance
α_1	MSA & Living with Roommates vs. Other Marital & No Roommates	15.142%	1.577%	**
α_2	MSA & No Roommates vs. Other Marital & No Roommates	4.015%	0.550%	**
α_3	Other Marital & Living with Roommates vs. Other Marital & No Roommates	3.266%	0.572%	**
β_1	'6 to 15' vs. '0 to 5' years in U.S.	-1.083%	0.379%	**
β_2	'15 plus' vs. '0 to 5' years in U.S.	-1.699%	0.348%	**
β_3	Constant Term	1.629%	0.389%	**
γ_1	Middle vs. Low Tier (Revised Model)	0.050%	0.308%	.
γ_2	High vs. Low Tier (Revised Model)	0.642%	0.306%	**
γ_3	Highest vs. Low Tier (Revised Model)	1.557%	0.273%	**
α_0	Constant Term	1.967%	0.393%	**

The results of this linear model, shown in Table 3, do not predict remittances as well as the multiplicative model shown in Table 2. Nevertheless, it has an R^2 of 4.97%, much higher than BEA's previous model. This linear model will be the basis for the discussion in sections 3a)-3e).

Table 4 compares remittances under the previous and revised models using the remittance rates shown in Table 2, which are the basis for BEA's published estimates for 2009-2011. The revised model and the previous model both use the same population and income data from the ACS. The different remittance totals result from the different demographic categories and different remittance rates applied to each category. The statistics for 2008 are the same for both models because, as discussed previously, the revised model is calibrated to equal the 2008 published data.

Table 4: Annual Remittances from the U.S. [9]

Year	Number of Adult Immigrants (millions)	Average Income per Immigrant	Remittances per $1,000 of income		Total Remittances ($ billions)	
			Previous Model	Revised Model	Previous Model	Revised Model
2001	30.6	$25,633	$31.33	$31.08	$26.5	$27.1
2002	32.2	$25,981	$31.92	$30.94	$27.7	$27.4
2003	32.8	$26,180	$31.74	$31.67	$28.0	$27.5
2004	33.4	$27,256	$31.62	$31.75	$30.4	$30.1
2005	34.9	$28,012	$32.88	$31.33	$31.3	$30.9
2006	36.2	$28,453	$32.63	$33.40	$34.3	$35.3
2007	36.8	$30,163	$32.46	$32.83	$36.9	$37.1
2008	37.1	$31,536	$31.96	$31.96	$38.5	$38.5
2009	37.6	$30,585	$31.86	$30.76	$37.4	$36.1
2010	39.1	$29,668	$32.04	$30.98	$37.1	$35.6

The most striking result of the revised model is the much larger decrease in remittances from 2008 to 2009. According to BEA's previous model, remittances decreased by 3% ($38.5 billion to $37.4 billion). The revised model shows a 6% drop in the same time period ($38.5 billion to $36.1 billion). The larger drop is mainly caused by decreases in the population of migrants who are married (spouse absent) and the average income of immigrants who are living with roommates. In the revised model, these immigrants remit more than average, so changes in their population and income have a substantial impact on remittances.

a) U.S. citizens born abroad of American parents do not remit

About 3% of immigrants are children of U.S. citizens who lived abroad at the time of their birth. We create a dummy variable 'All Other Immigrants' that is 0 for U.S. citizens born abroad of American parents and 1 for immigrants who acquired citizenship later or are not yet citizens. The regression shown in the paper does not control for other demographics, but those controls do not change results. The precise formula and regression results are given below:

$$\text{Remittance rate} = \alpha + \beta * \text{'All Other Immigrants'} + \varepsilon$$

[9] This paper used slightly different source data than those used for the published estimates, so population, average income, and remittance rates do no track precisely with the published estimates.

Table 5: Remittance Rates by Citizenship at Birth

Variable	Variable description	Coefficient	Standard Error	Statistical Significance
β	All Other Immigrants vs. U.S. Citizens Born Abroad	1.377%	0.351%	***
α	Constant Term	-0.016%	0.338%	.

The constant term, α, for this regression is very small and statistically indistinguishable from 0. This indicates that U.S. citizens born abroad of American parents remit almost nothing. Their low remittance rate is not surprising. Most U.S. citizens born abroad of American parents arrived in the U.S. as children and have few ties to their country of birth. In the revised model, we assume that they remit similarly to individuals born in the United States, who are not part of this study.

b) Change the family structure categories from Children/No Children to MSA/Other Marital

As discussed in the prior section, BEA's previous model assumed that immigrants send less money if they have children in their household. However, in Table 1, the presence of children in the household was shown to be a relatively weak predictor of remittances. We use married, spouse absent (MSA) instead because it is a much stronger predictor of remittances.

The CPS and ACS both have six marital status categories: i) Married, spouse present; ii) Married, spouse absent; iii) Separated; iv) Divorced; v) Widowed; and vi) Never Married. It might seem that MSA and separated are virtually the same. In fact, MSA refers to married couples with a good relationship who can't live together because jobs or other outside factors result in them living in different countries or different cities. In contrast, separated refers to married couples with relationship problems who are living apart while they work through the problems or prepare for divorce. Immigrants appear to understand the distinction between the two categories reasonably well – many separated individuals have boyfriends or girlfriends living in their household, but no MSA individuals do.

We argue that MSA immigrants send remittances to support their spouse abroad. The absent spouse may also be caring for young children. Some MSA immigrants may have spouses in the U.S., but it seems reasonable to assume that most MSA immigrants have spouses abroad. We also experimented with including extra controls for separated, divorced, or never married. We found that the extra controls sometimes were statistically significant but were never powerful predictors of remittances.

We test which family structure variables are better predictors of remittances by including a dummy variable for MSA. The precise formula and regression results are below:

Remittances = $\alpha_0+\alpha_1$*'No Children' + α_2*'MSA' + β_1*'6 to 15 years in US' + β_2*'16 to 30 years in US' + β_3*'30 plus years in US' +γ_1*'Middle Tier' +γ_2*'High Tier' +γ_3*'Highest Tier' +ε

Table 6: Remittance Rates by Family Structure

Variable	Variable description	Coefficient	Standard Error	Statistical Significance
α_1	'No Children' vs. 'Has Children'	0.361%	0.197%	*
α_2	MSA vs. Other marital	4.955%	0.529%	**
β_1	'6 to 15' vs. '0 to 5' years in U.S.	-1.361%	0.381%	**
β_2	'16 to 30' vs. '0 to 5' years in U.S.	-2.114%	0.368%	**
β_3	'30 plus' vs. '0 to 5' years in U.S.	-2.403%	0.372%	**
γ_1	Middle vs. Low Tier Birth Country	0.668%	0.312%	**
γ_2	High vs. Low Tier Birth Country	0.612%	0.275%	**
γ_3	Highest vs. Low Tier Birth Country	1.431%	0.259%	**
α_0	Constant Term	1.967%	0.393%	**

As in Table 1, we find that immigrants without children in the household remit more. However, MSA is a much more powerful predictor of remittances. The coefficient for MSA is fifteen times as large as the coefficient for 'no children.' The F-statistic for the MSA variable is 9.4, well above the level of significance. Furthermore, the additional variable raises the adjusted R^2 from 1.66% to 3.04%.

c) Add Living with Roommates

We extend the results in section b) by adding a new category: living with a roommate vs. no roommates. In combination, there are four possible household structures: MSA with roommates, MSA without roommates, other marital with roommates, and other marital without roommates. When measuring roommate status, we count both the head of household and the people listed as roommate/boarder. This ensures that the variables are not affected by who filled out the form.

We exclude young adults from the roommate variable. Young adults are much more likely to live with roommates than older adults. This is true for college students and non-students. Young adults are more willing to accept roommates because they are much less likely to be married or have children. In addition, young adults move frequently and have lower savings. Therefore, they value the flexibility of

roommates more than average. For young adults, the presence of roommates is more likely related to these advantages than a desire to send more remittances. We will handle this issue by only counting adults over 25 in the roommate count.

There are several reasons that immigrants living with roommates send more money. Holding income constant, people sending significant remittances have less money available to spend on housing. Therefore, they might share housing to save money. Another reason is that roommates allow more housing flexibility than a standard apartment lease or mortgage payment. Immigrants who visit their birth country frequently are likely to value that flexibility the most. Those same frequent visitors probably also send larger remittances.

We test which family structure variables are better predictors by including three separate dummy variables: one for MSA and living with roommates, one for MSA and not living with roommates, and one for not MSA and living with roommates. The precise formula and regression results are below:

$$\text{Remittances} = \alpha_0+\alpha_1*\text{'No Children'} + \alpha_2*\text{'MSA \& Roommates'} +\alpha_3*\text{'MSA \& No Roommates'} + +\alpha_4*\text{'Other Marital \& Roommates'} + \beta_1*\text{'6 to 15 years in US'} + \beta_2*\text{'16 to 30 years in US'} + \beta_3*\text{'30 plus years in US'} +\gamma_1*\text{'Middle Tier'} +\gamma_2*\text{'High Tier'} +\gamma_3*\text{'Highest Tier'} +\varepsilon$$

Table 7: Remittance Rates by Family Structure and Roommates

Variable	Variable description	Coefficient	Standard Error	Statistical Significance
α_1	'No Children' vs. 'Has Children'	0.144%	0.198%	.
α_2	MSA & Living with Roommates vs. Other Marital & No Roommates	15.238%	1.583%	**
α_3	MSA & No Roommates vs. Other Marital & No Roommates	3.844%	0.553%	**
α_4	Other Marital & Living with Roommates vs. Other Marital & No Roommates	3.199%	0.579%	**
β_1	'6 to 15' vs. '0 to 5' years in U.S.	-1.123%	0.380%	**
β_2	'16 to 30' vs. '0 to 5' years in U.S.	-1.759%	0.368%	**
β_3	'30 plus' vs. '0 to 5' years in U.S.	-1.957%	0.374%	**
γ_1	Middle vs. Low Tier Birth Country	0.629%	0.310%	**
γ_2	High vs. Low Tier Birth Country	0.594%	0.273%	**
γ_3	Highest vs. Low Tier Birth Country	1.303%	0.257%	**
α_0	Constant Term	1.730%	0.392%	**

Table 7 shows that the presence of roommates is a very powerful predictor of remittances. Immigrants who are MSA increase their remittances by 11% (3.844% to 15.238%) if they are living with roommates. Immigrants with other marital statuses have lower base remittance rates, but the relative effect is similar. The two additional variables increase the adjusted R^2 from 3.04% to 4.42%.

Once we control for marital status and the presence of roommates, children in the U. S. household have no significant impact on remittances. This does not mean that children don't influence remittances. However, immigrants with children in the U.S. household are much less likely to be MSA or living with roommates. Therefore, the effect of children is captured by the revised demographic categories. The adjusted R^2 holds steady at 4.42% when we drop the dummy variable 'no children' from our model.

d) Reduce the number of time codes from 4 to 3

BEA's previous model used time in the U.S. to predict remittances. Over time, immigrants shift their economic focus from their birth country to the U.S. and send a lower portion of their income. The previous model has four separate time categories: '0 to 5,' '6 to 15,' '16 to 30', and '30 plus.'

In Table 1 and Table 7, we showed that the CPS data do not fully support BEA's previous time categories. Consistent with BEA's previous model, recent immigrants send the most and immigrants who have been in the U.S. for 16 or more years send the least. However, there is little difference in remittance rates for immigrants in the categories '16 to 30' and '30 plus.' Furthermore, alternative regression techniques show an apparent rise in remittances from '16 to 30' to '30 plus.' Because of these results, we will combine the two time codes, '16 to 30' and '30 plus,' into a single time code, '15 plus.' This aggregation raises the adjusted R^2 in Table 7 from 4.42% to 4.43%.

The stabilization of remittance rates 15 years after immigration may be related to children. Many immigrants send money home to support minor children abroad. After 15 years, most of the children are old enough to come to the U.S. or support themselves in their country of birth.

e) Reallocate countries within the geographic tiers

BEA's previous and revised models have four separate geographic tiers: low, middle, high, and highest. We showed in Section 2 that the previous country allocations are not the best match for reported remittance behavior in the CPS. Immigrants from countries in the low tier gave significantly less and immigrants from the highest tier gave more. But immigrants from middle and high tier

countries gave similar amounts. We introduce a new allocation of countries into geographic tiers. The new allocation is based on three immigration rules – whether the country is oversubscribed for applications for legal permanent residence, whether a country has temporary protected status, and whether the country has a visa waiver program with the U.S. – and one birth country characteristic – the World Bank's Governance scores for government effectiveness and regulatory quality. We will explain why each criterion matters.

i) Oversubscribing

Oversubscribing increases the length of time required for immigrants to bring family members to the U.S. Congress awards legal permanent residence status (green cards) according to a complex formula. First, the number of green cards for each visa type is set by Congress. Second, the total number of green cards available for each country is limited to 7% of the total available. In practice, four countries are limited by the 7% ceiling: Mexico, China, India, and the Philippines. Accordingly, immigrants from those countries are expected to be more likely to be supporting family abroad.

ii) Temporary Protected Status

Temporary Protected Status also increases the length of time required for immigrants to bring family members to the U.S. The Department of Homeland Security uses this category for legal and illegal immigrants who cannot return because their birth country is not safe. In 2008, El Salvador, Nicaragua, Honduras, Somalia, and Sudan had Temporary Protected Status. Since then, Haiti has been added to the list because of the 2010 earthquake. Immigrants in this category are allowed to stay in the U.S. but they are not allowed to bring family members to join them. Therefore, immigrants from those countries are expected to be more likely to be supporting family abroad.

iii) Visa Waver Program

High income in the birth country reduces the need for remittances by friends and family abroad. For most countries, immigrants to the U.S. earn substantially more than they did before they arrived; however, there is not much income difference between the U.S. and wealthy countries like Canada and those in Western Europe. In addition, wealthy countries have generous social security and welfare programs. Accordingly, very few immigrants have families back home who depend on them for basic living expenses. However, they will still send money for gifts and special occasions.

Another reason for the low remittances to wealthy countries is ease of immigration. For a variety of reasons, U.S. immigration law favors people from wealthy countries. Accordingly, most immigrants from Canada or Western Europe can bring their spouses and children with them when they move to the U.S. Therefore, they have fewer family members abroad to whom they can send money.

In this paper, we will not control for income per capita in the birth country directly. Instead, we will use the presence of a visa waiver program in the U.S. as a proxy for wealth. A visa waiver allows temporary visitors from selected countries to enter the U.S. without applying for a visa. In practice, countries with visa waivers are all high income. The visa waiver program is very responsive to income changes. For example, Argentina's and Uruguay's visa waivers were revoked during their financial crisis of 2002, and many Eastern European countries were recently granted visa waivers as they became wealthier. We also experimented with simply using income per capita in the country of birth. We found qualitatively similar results, but visa waiver status was a stronger predictor and easier to implement.

iv) World Bank Indicators for Government Policy

Government policy in the birth country impacts both the need for remittances and the potential impact of those remittances. We use two indicators for government policy: government effectiveness and regulatory quality. The first indicator measures the quality of public goods such as schools, roads, and other government-provided services. The second indicator measures the ability of private business to hire workers, manufacture products, and sell goods without government interference.

We believe that these two indicators are a proxy for the value of money in the birth country. Holding everything else fixed, the family left behind needs less money if the government services such as schools, hospitals, and welfare are high quality enough that they can rely on them when necessary.[10] The relationship between regulatory quality and the value of money is more complex. We hypothesize that more private goods and services are available in places with better regulatory quality. Therefore, the family left behind can buy more things with their remittances. The difference between the quality of government services and the quality of service that can be purchased with remittances is what matters. We combine these indicators into a single summary value:

[10] Many countries demand bribes for schools, hospitals, and other government services. In those countries, the value of money is higher because people need money to access what they should have for free. The World Bank has an indicator for 'control of corruption' that we could incorporate into our model. However, corrupt societies typically score very low on the government effectiveness score. Therefore, bribes are implicitly counted already.

Value of Money = Regulatory Quality – Government Effectiveness

For example, suppose that an immigrant leaves young children behind to come to the U.S. He or she wants to make sure the children go to the best school possible. In countries where government schools are free and high quality, there is no need to send money for private school. Additionally, there is no need to send money for private school if private school is not available at any price. On the other hand, in a country with poorly run government schools and well-functioning private schools, remittances may make an enormous difference to the child's education. Remittances have a greater impact when government services are low quality and private services are high quality.

The indicator for the value of money is not just a proxy for GDP per capita. The low end of the value of money scale includes wealthy countries like Barbados and Singapore as well as poor countries like Zimbabwe and Cuba. The high end of the scale includes wealthy countries like Kuwait and Ireland as well as poor countries like Haiti and Uganda. In our regressions, we use the five-year average of the World Bank Indicators for 2005 to 2009. This avoids many of the fluctuations caused by single years.

v) New Tiers for Countries

We translated these four factors into new geographic tiers. First, we put all countries with an active visa waiver program as of 2008 in the 'low' tier.[11] Next, we put all countries with future visa waiver programs in the 'middle' tier. Finally, we used a point system to divide the remaining countries. All countries start with three points. A country gets one more point if it is oversubscribed or has temporary protected status. A country loses one point if its value of money score is less than India (-.251) and gains one point if its value of money score is greater than or equal to Mexico (0.264). These precise cut-offs ensure that India, Mexico, and the Philippines are all placed in the 'highest' tier, but China is only in the 'high' tier. Countries with two points are placed in the 'middle' tier, those with three points are placed in the 'high' tier, and those with four or more points are placed in the 'highest' tier.

We test which country tiers are better predictors by including three new dummy variables, one for each new tier. The two tier assignments are different enough that multi-collinearity is not a serious problem. This can be seen by the fact that the standard errors for the previous model tiers are only slightly higher than they were in Table 7. The precise formula and regression results are below:

$$\text{Remittance rate} = \alpha_0 + \gamma_{1p} * \text{'Middle, Previous'} + \gamma_{2p} * \text{'High, Previous'} + \gamma_{3p} * \text{'Highest, Previous'} +$$

[11] The Czech Republic and Slovakia are also included in the 'low' tier.

γ_{1r} *'Middle, Revised' +γ_{2r} *'High, Revised' +γ_{3r} *'Highest, Revised'+

α_1*'MSA & Roommates' +α_2*'MSA & No Roommates' +α_3*'Other Marital & Roommates' +

β_1*'6 to 15 years in U.S.' + β_2*'15 plus years in U.S.' +ε

Table 8: Remittance Rates by Country Tiers

Variables	Variable description	Coefficient	Standard Error	Statistical Significance
γ_{1p}	Middle vs. Low Tier (Previous Model)	-0.073%	0.469%	.
γ_{2p}	High vs. Low Tier (Previous Model)	-0.090%	0.453%	.
γ_{3p}	Highest vs. Low Tier (Previous Model)	0.184%	0.462%	.
γ_{1r}	Middle vs. Low Tier (Revised Model)	0.072%	0.464%	.
γ_{2r}	High vs. Low Tier (Revised Model)	0.645%	0.506%	.
γ_{3r}	Highest vs. Low Tier (Revised Model)	1.47%	0.514%	**
α_1	MSA & Living with Roommates vs. Other Marital & No Roommates	15.108%	1.578%	**
α_2	MSA & No Roommates vs. Other Marital & No Roommates	3.997%	0.550%	**
α_3	Other Marital & Living with Roommates vs. Other Marital & No Roommates	3.247%	0.572%	**
β_1	'6 to 15' vs. '0 to 5' years in U.S.	-1.090%	0.379%	**
β_2	'15 plus' vs. '0 to 5' years in U.S.	-1.721%	0.349%	**
α_0	Constant Term	1.648%	0.389%	**

In Table 1, we showed that the previous tiers were valid predictors of remittances. But Table 8 shows that the revised tiers are more powerful predictors. The new tiers are jointly significant with an F-statistic above 9. In contrast, the previous tiers are jointly and individually insignificant. We also tried comparing regressions with just the revised tiers and just the previous tiers. The adjusted R^2 rises from 4.43% to 4.84% when we use the new tiers to predict remittance rates.

The most important countries affected by the new tiers are India, Cuba, Vietnam, and the Philippines. BEA's previous tiers placed India in the middle remitting category and the Philippines in the high remitting category. Based on the fact that both countries are oversubscribed and have a high value of money score, we re-classify India and the Philippines into the highest category. BEA's previous tiers placed Cuba in the highest remitting category and Vietnam in the high category. Based on the fact that Cuba and Vietnam have low value of money scores, we place them in the middle category.

The value of money score is new to BEA's model so we devoted additional attention to this factor. As a robustness test, we checked to see if a single country created the correlation between high value of money and high remittances. The ten largest immigrant sources in the U.S. are Mexico, the Philippines, India, China, El Salvador, Germany, Vietnam, Cuba, Canada, and South Korea. We tested removing each one individually, but the results remained the same. The results even hold if we remove all ten of the largest immigrant sources. We also tried regressing individual continents separately. We found similar results with a subsample of immigrants from the Americas and a subsample of immigrants from Asia. Because of all these checks, we believe that the result is real. Government policy in the birth country can influence remittances. Note that the value of money indicator has no impact on remittances for immigrants from wealthy countries.

4. Testing the Revised Model against Alternative Data Sources

New Immigrant Survey Data

The main alternative dataset to compare against the revised model is the New Immigrant Survey (NIS). The NIS tracks a sample of immigrants who were recently given legal permanent residence status. This is a very different population from the CPS, which covers all immigrants regardless of migration status. Because of this difference, we expect the demographics of the NIS population to differ from those in the CPS. The NIS is a very long survey with many different questions on the immigrant's family, migration experience, work experience, and other topics of interest. In this analysis, we summarized the NIS data to make them comparable to the CPS data. We use the first wave of NIS data, which is publicly available.

As expected, the demographics of the population in the NIS are very different from the demographics of the population in the CPS. In the NIS, only 1.0% of respondents are married, spouse absent (MSA). In the CPS, 3.2% of immigrants are MSA. In the NIS, only 2.3% of immigrants are living with roommates. In the CPS, 4.9% of immigrants are living with roommates. In Section 3, we showed that immigrants who are MSA and living with roommates remit much more than average. Accordingly, the CPS population is predicted to send more remittances than average. Despite the different demographics, the NIS and the CPS give roughly similar coefficients for each demographic variable included in our model.

a) U.S. citizens born abroad of American parents send no money home in the NIS

All of the individuals in the NIS are newly legalized permanent residents. U.S citizens born abroad of American parents have automatic citizenship just like people born in the U.S. Therefore, they are not included in the sample, and we cannot test whether these individuals remit differently.

b) Change the family structure categories from Children/No Children to MSA with Roommates/MSA without Roommates/Other Marital with Roommates/Other Marital without Roommates

We test which family structure variables are better predictors of remittances with the same OLS regression used in section 3c). The full results are available upon request, and the variables of interest are shown below:

Table 9: Remittance Rates by Family Structure and Roommates

Variable	Variable description	Coefficient	Standard Error	Statistical Significance
α_1	'No Children' vs. 'Has Children'	0.864%	0.256%	**
α_2	MSA & Living with Roommates vs. Other Marital & No Roommates	21.103%	2.182%	**
α_3	MSA & No Roommates vs. Other Marital & No Roommates	4.320%	0.556%	**
α_4	Other Marital & Living with Roommates vs. Other Marital & No Roommates	2.313%	0.869%	**

Consistent with BEA's previous model, immigrants without children present remit more. Consistent with the revised model, MSA and roommates are more powerful predictors of remittances. The coefficients are also quite close to those observed in the CPS. In the CPS sample, α_2 was 15.238%, α_3 was 3.844%, and α_4 was 3.199%.

Even though the regression coefficients in Table 9 are similar to those in Table 7, the impact on R^2 is very different. In the CPS data, Table 7 produces an R^2 of 4.42%, much higher than the R^2 of 1.66% when using children/no children. In contrast, the MSA and roommates variables do not increase the R^2 much for the NIS sample. The difference is driven by the sample studied. The NIS has very few MSA individuals, so changing their remittances has little impact on the overall prediction.

c) Reduce the number of time in the U.S. codes from 4 to 3 in the NIS

We test the impact of time in the U.S. with the same OLS regression used in section 3c) and shown in Table 7. The full results are available upon request, and the variables of interest are shown below:

Table 10: Testing BEA's Time Categories

Variable	Variable Description	Coefficient	Standard Error	Statistical Significance
β_1	'6 to 15' vs. '0 to 5' years in U.S.	0.58%	0.35%	*
β_2	'16 to 30' vs. '0 to 5' years in U.S.	0.15%	0.54%	.
β_3	'30 plus' vs. '0 to 5' years in U.S.	1.69%	1.34%	.

Surprisingly, we found that immigrants who arrived 30 plus years ago send more than immigrants who arrived 16 to 30 years ago. In some specifications we found similar results in the CPS data but not in the linear OLS presented in the Table 7. Future research is needed.

d) Change some countries from one geographic tier to another in the NIS

We test which country tiers are better predictors with the same OLS regression shown in section3e).[12] Just like before, the two tier assignments are different enough that multi-collinearity is not a serious problem. The full results are available upon request, and the variables of interest are shown below:

Table 11: Remittance Rates by Country Tiers

Variable	Variable description	Coefficient	Standard Error	Statistical Significance
γ_{1p}	Middle vs. Low Tier (Previous Model)	-2.52%	0.89%	**
γ_{2p}	High vs. Low Tier (Previous Model)	0.04%	0.69%	.
γ_{3p}	Highest vs. Low Tier (Previous Model)	-0.67%	0.78%	.
γ_{1r}	Middle vs. Low Tier (Revised Model)	2.23%	0.70%	**
γ_{2r}	High vs. Low Tier (Revised Model)	1.09%	0.52%	*
γ_{3r}	Highest vs. Low Tier (Revised Model)	2.81%	0.61%	**

[12] The tiers developed in Section 3 are calibrated against the immigration rules and country characteristics in place in 2008, slightly later than the NIS data, which were collected in 2003 and 2004. We believe that country tiers change slowly over time. Therefore, we did not adjust the geographic tiers for this time difference.

The results for the revised geographic tiers are mixed. Immigrants in the 'low tier' give less than immigrants in the three remaining tiers. However, the average remittance rate is larger for immigrants in the 'middle tier' than the 'high tier.' Furthermore, the 'highest tier' remits only slightly more than the 'middle tier.' Nevertheless, the revised tiers are jointly significant and the previous tiers are not.

World Bank Remittance Statistics

The other alternative dataset to compare the revised model to is the World Bank's remittance estimates. These statistics are available at http://data.worldbank.org/topic. The World Bank data are aggregated from each country's reporting of statistical data to the IMF.[13] The World Bank remittance statistics may be incorrect if countries' estimation techniques are flawed. Unfortunately, the World Bank data are not bilateral and provide only total remittances received by each country. Therefore, we cannot directly compare predicted remittances sent from the U.S. with reported remittances received from the U.S.

<u>e) Testing whether aggregate remittances are correlated with the value of money score from 3e)</u>

In section 3e), we introduced new geographic tiers based on four factors: whether the country is oversubscribed by potential immigrants; whether the country has temporary protected status; whether the country has a visa waiver program; and the value of money score in that country. The first three factors are part of U.S. immigration law, so they primarily apply to immigrants to the U.S. The World Bank's remittance statistics, however, include remittances from emigrants in all countries. It is unlikely that U.S. immigration law influences remittances outside the United States, so we cannot test the impact of these factors in the World Bank data. Instead, we will focus on the value of money score, which is a characteristic of the birth country. We will assume that immigrants in non-U.S. countries respond the same way to the value of money score as U.S. immigrants.

We estimate the impact of value of money on remittances with the OLS regression. In order to focus on the 'value of money score,' we include a dummy variable for each country in the sample and a dummy variable for each year. This regression technique is known as difference in difference. The formula is:

[13] The World Bank defines remittances as the sum of personal transfers, compensation of employees, and migrants' transfers. This is a broader definition than BEA's accounts, so their numbers will not match precisely.

Remittances Per Emigrants[14] = $\alpha+\beta$*'Value of Money Score' +

γ*'Country Fixed Effects' +δ*'Year Fixed Effects'+ε

Unlike the earlier regressions, 'Value of Money Score' is a linear variable ranging from -3 to 3. Just like we did in section 3e), we average the World Bank scores over five years to get a smoother number than if we took a single year's data. Our sample runs from 2000 to 2009 for most countries, but a few countries enter the sample later.

We estimate that β is \$976 using an un-weighted regression. In other words, one extra point on the value of money scale raises remittances by \$976 per emigrant. The mean remittance is \$1,818 per emigrant, so this is a relatively large effect. If we weight by the emigrant population, the coefficient falls slightly to \$639 per emigrant, but it remains statistically significant. As a robustness check, we tried removing Mexico, India, China, and the Philippines from our sample. We found that results remained similar. We also tried splitting the sample by continent. We found that the point estimate for 'value of money' was positive and significant for North America, Europe, and Africa. For Asia, it is positive and insignificant (p = .206) and for South America, it is negative and insignificant. Because of these robustness checks, we believe that the value of money scale has a real impact on remittances. Regression results are available upon request.

f) Testing the revised country tiers against World Bank data

For this section, we restrict the sample to the 13 countries that send more than half of their emigrants to the U.S.: Belize, Costa Rica, the Dominican Republic, El Salvador, Guatemala, Guyana, Honduras, Japan, Jamaica, Laos, Mexico, Panama, and Trinidad & Tobago. This list leaves out many important sending countries like India, China, and the Philippines because they send significant numbers of emigrants to other countries. It also leaves out some countries that send most of their emigrants to the U.S. but that don't have remittance data in the World Bank statistics. In particular, Cuba is missing. There is a very high correlation between average remittances in one year and average remittances in the next, so we only examine the 2008 remittance data.[15]

[14] The number of emigrants is for 2010. We could not find annual data. We use the number of immigrants in the U.S. to impute emigrants for each year. This method may be refined later.

[15] Results are similar if we use the average for all years in the dataset or cluster observations by country.

For the 13 countries in our sample, the number of U.S. immigrants is highly correlated with predicted remittances from BEA's previous model, predicted remittances from BEA's revised model, and the World Bank statistics. Accordingly, all of the remittance numbers are very highly correlated. In order to test our model better, we will compare remittances per person instead.

This section is primarily a test of the country tiers developed in section 3e). To compare the previous and revised models, we calculated remittances per immigrant and then estimated two OLS regressions:

Remittances Per Immigrant = (World Bank Remittances)/(# Immigrants from ACS)

Remittances Per Immigrant = $\alpha_1+\beta_1$*'Predicted Remittances Previous Model' +ε

Remittances Per Immigrant = $\alpha_1+\beta_1$*'Predicted Remittances Revised Model' +ε

We found that the World Bank's remittances are positively correlated with predicted remittances, but the correlation is not high. BEA's previous model is not statistically significant and the revised model is only significant at the 10% level. Some of the differences may be caused by compensation of employees, which is included in the World Bank data.

These results suggest that BEA's revised tiers are slightly better than the previous tiers but are still not that close a match for remittances. However, the new tiers were calibrated to produce the best results for the full sample of immigrants to the U.S. The 13 countries tracked in this regression only provide 40% of immigrants to the U.S. and 49% of predicted remittances.

g) Changes in annual remittance rates, revised model vs. the World Bank statistics

Finally, we test whether predicted changes in remittance rates are correlated with changes in the World Bank statistics over time. For this regression, we assume that the new tiers in section 3e) remain fixed throughout the time period. Therefore, changing remittance rates over time are caused by changes in the demographic makeup and income of migrants to the U.S. The data used and the sample used are the same as in section f). In order to focus on the 'value of money score,' we include a dummy variable for each country in the sample and a dummy variable for each year. This regression technique is known as difference in difference.

Demographic changes are the main reason for differences in predicted remittances for a single country over time. Throughout the sample period, we hold country tiers fixed for each country. Therefore, this section is primarily a test of the household structure variables developed in sections 3b) and 3c). Each year, the ACS supplies new demographics for immigrants by country of birth. However, the remittance rates for each demographic category provided in Table 2 are held fixed. Therefore, mean remittance rates will change if a higher percentage of immigrants are MSA, living with roommates, or recently arrived in the U.S. To compare the previous and revised models, we estimate two OLS regressions:

$$\text{Remittances Per Immigrant} = \alpha_1+\beta_1*\text{'Predicted Remittances Previous Model'} + \gamma_1*\text{'Country Fixed Effects'} +\delta_1*\text{'Year Fixed Effects'}+\varepsilon$$

$$\text{Remittances Per Immigrant} = \alpha_1+\beta_1*\text{'Predicted Remittances Revised Model'} + \gamma_1*\text{'Country Fixed Effects'} +\delta_1*\text{'Year Fixed Effects'}+\varepsilon$$

We found that β is positive and statistically significant at the 5% level for BEA's previous model and at the 1% level for the revised model. Regression results are available upon request.

Conclusion

BEA uses a demographic model to predict the level of remittances that immigrants in the United States send abroad. In this paper, we tested the demographic variables in BEA's previous model and outlined a revised model with new demographic variables. The revised model has already been incorporated into BEA's international transactions accounts, beginning with BEA's published statistics for 2009.

We tested BEA's previous demographics by comparing remittance statistics produced by those demographics with remittance data reported on the Current Population Survey (CPS). We showed that the BEA's assumptions about family structure and time in the U.S. predict remittances reported on the CPS but are only weak indicators. We also showed that BEA's previous country tiers do not match remitting behavior very well. In particular, we show that immigrants who were previously classified separately into middle and high tier countries appear to remit the nearly same percentage of their income.

We then introduced several modifications to improve BEA's model. First, we introduced two new demographic characteristics – marital status and presence of roommates – to predict remittance behavior. Second, we changed some countries from one geographic tier to another. We showed that the new demographics and geographic tiers do a better job of predicting remittance rates. Finally, we multiplied the CPS remittances by a constant factor to match BEA's previously published estimates for 2008. The modifications improve upon BEA's previous model in two respects: 1) the geographic distribution of remittances is more in line with the breakdown suggested by behavior in the CPS and 2) the year-to-year changes in remittances produced by the revised model should be more accurate than changes produced by the previous model. Year-over-year changes in personal transfers reflect changes in the population, income, and demographic structure of the immigrant population in the United States. The new, more powerful demographic characteristics in the revised model will allow BEA to more accurately estimate these changes.

Finally, we tested our modifications against two alternative datasets: the New Immigrant Survey (NIS) and World Bank remittance statistics. We found that the demographic characteristics have similar effects in the NIS as they do in the CPS. We found that the revised model matches the World Bank statistics better than BEA's previous model.

Appendix A: Estimation Techniques Used and Final Results

In order to use the Current Population Survey (CPS) data more efficiently, we need to impose some structure on the regression. We assume that each demographic factor has the same relative effect on remittances, regardless of the other variables. This is equivalent to the following model:

$$\text{Remittances} = (\alpha_0+\alpha_1*\text{'MSA \& Roommates'} +\alpha_2*\text{'MSA \& No Roommates'} +\alpha_3*\text{'Other Marital \& Roommates'})*(1+ \gamma_1*\text{'Middle Tier'} +\gamma_2*\text{'High Tier'} +\gamma_3*\text{'Highest Tier'})*(1+ \beta_1*\text{'6 to 15 years in US'} + \beta_2*\text{'16 to 30 years in US'} + \beta_3*\text{'30 plus years in US'})*(1+\varepsilon)$$

Our estimation approach to the model above is nonstandard. This is imposed by the structure of the CPS data. BEA's demographic model for remittances is based on individuals. The CPS only records household remittances. So, for example, two immigrants in the household might have arrived in the U.S. at different times, have different marital statuses, and be from different birth countries. Thus, we cannot regress household remittances on household characteristics. Instead, we needed to translate BEA's individual variables into household variables.

To do this we use a step-wise approach to estimate the multiplicative model. We start out with BEA's previous model. (Because of BEA policy, we cannot reveal the precise remittance rates for each demographic category.) First, we estimate relative remittance rates for the new household structure, maintaining the old definitions of time in the U.S. and country of birth. Next, relative remittance rates by the new time in the U.S. definitions are combined with the new estimates for household structure and the old definition of country of origin. Finally, relative remittance rates by the new definition of country of birth are estimated and combined with the new estimates of household structure and time in the U.S.

First, we estimate predicted remittances for four separate variables: married, spouse absent (MSA) immigrants living without roommates; other marital immigrants with roommates; MSA without roommates; and other marital without roommates. We then estimate the regression:

$$\text{Reported Remittances} = \alpha_1*\text{PredRemit}_{\text{MSA, with roommates}} + \alpha_2*\text{PredRemit}_{\text{Other Marital, with roommates}} \alpha_3*\text{PredRemit}_{\text{MSA, no roommates}} + \alpha_4*\text{PredRemit}_{\text{Other Marital, no roommates}} +\varepsilon$$

The point estimates for the α's are: α_1 is 2.042, α_2 is 0.830, α_3 is 0.652, and α_4 is 0.222.

For the second step, we use BEA's previous country tiers and the relative family structure rates estimated above to predict how much each immigrant would remit if he or she had just arrived in the U.S. As before, these remittance rates depend on BEA's previous model for country tiers. We then estimate predicted remittances for the three time categories: immigrants in the '0 to 5' time category, immigrants in the '6 to 15' time category, and immigrants in the '15 plus' time category. We then estimate the regression:

$$\text{Reported Remittances} = \beta_1 * \text{PredRemitNew}_{0 \text{ to } 5} + \beta_2 * \text{PredRemitNew}_{6 \text{ to } 15} + \beta_2 * \text{PredRemitNew}_{15 \text{ plus.}}$$

The point estimate for β_1 is 1.069, β_2 is 0.918, and β_3 is 0.547.

For the third step, we use the relative family structure rates and time in the U.S. rates estimated above to predict how much each immigrant would remit if they were born in a low tier country. Even though the starting point was BEA's previous model, all estimates are now from the α's and β's given above. We estimate predicted remittances for the four country tiers: immigrants born in low tier countries, immigrants born in middle tier countries, immigrants born in high tier countries, and immigrants born in highest tier countries. All of the tiers used are taken from the revised geographic tiers described in section 3e), not BEA's previous tiers. As before, we estimate the regression:

$$\text{Reported Remittances} = \gamma_1 * \text{PredRemit}_{\text{Low}} + \gamma_2 * \text{PredRemit}_{\text{Middle}} + \gamma_3 * \text{PredRemit}_{\text{High}} + \gamma_4 * \text{PredRemit}_{\text{Highest}} + \varepsilon$$

The point estimate for γ_1 is 2.300154, γ_2 is 2.286321, γ_3 is 5.734, and γ_4 is 15.002.

Each of the three regression steps described earlier depend on the values estimated for the other two stages. For example, people who are MSA generally arrived much more recently than the rest of the population. Therefore, the coefficient for MSA changes when the coefficient for new arrivals changes. To see if it would improve model fit, we repeated the estimations described above until the estimated remittance rates converged. The repetitions improved the model's fit, and the resulting remittance rates are used in the final model. However, differences between the initial and final rates were small.

We experimented with estimating independent remittance rates for each of the 48 country tiers, household structure, and time in the U.S. categories. However, many of those 48 independent rates have very high standard errors. Those results are available upon request.

Table 12: Coefficients Used For Each Demographic Category

Revised Geo Tier	Household Structure	0 to 5	6 to 15	15 plus
Low	Other Marital & No Roommates	$\alpha_4*\beta_1*\gamma_1*adj_1$	$\alpha_4*\beta_2*\gamma_1*adj_2$	$\alpha_4*\beta_3*\gamma_1*adj_3$
Low	Other Marital & Has Roommates	$\alpha_2*\beta_1*\gamma_1*adj_4$	$\alpha_2*\beta_2*\gamma_1*adj_5$	$\alpha_2*\beta_3*\gamma_1*adj_6$
Low	MSA & No Roommates	$\alpha_3*\beta_1*\gamma_1*adj_7$	$\alpha_3*\beta_2*\gamma_1*adj_8$	$\alpha_3*\beta_3*\gamma_1*adj_9$
Low	MSA & Has Roommates	$\alpha_1*\beta_1*\gamma_1*adj_{10}$	$\alpha_1*\beta_2*\gamma_1*adj_{11}$	$\alpha_1*\beta_3*\gamma_1*adj_{12}$
Middle	Other Marital & No Roommates	$\alpha_4*\beta_1*\gamma_2*adj_{13}$	$\alpha_4*\beta_2*\gamma_2*adj_{14}$	$\alpha_4*\beta_3*\gamma_2*adj_{15}$
Middle	Other Marital & Has Roommates	$\alpha_2*\beta_1*\gamma_2*adj_{16}$	$\alpha_2*\beta_2*\gamma_2*adj_{17}$	$\alpha_2*\beta_3*\gamma_2*adj_{18}$
Middle	MSA & No Roommates	$\alpha_3*\beta_1*\gamma_2*adj_{19}$	$\alpha_3*\beta_2*\gamma_2*adj_{20}$	$\alpha_3*\beta_3*\gamma_2*adj_{21}$
Middle	MSA & Has Roommates	$\alpha_1*\beta_1*\gamma_2*adj_{22}$	$\alpha_1*\beta_2*\gamma_2*adj_{23}$	$\alpha_1*\beta_3*\gamma_2*adj_{24}$
High	Other Marital & No Roommates	$\alpha_4*\beta_1*\gamma_3*adj_{25}$	$\alpha_4*\beta_2*\gamma_3*adj_{26}$	$\alpha_4*\beta_3*\gamma_3*adj_{27}$
High	Other Marital & Has Roommates	$\alpha_2*\beta_1*\gamma_3*adj_{28}$	$\alpha_2*\beta_2*\gamma_3*adj_{29}$	$\alpha_2*\beta_3*\gamma_3*adj_{30}$
High	MSA & No Roommates	$\alpha_3*\beta_1*\gamma_3*adj_{31}$	$\alpha_3*\beta_2*\gamma_3*adj_{32}$	$\alpha_3*\beta_3*\gamma_3*adj_{33}$
High	MSA & Has Roommates	$\alpha_1*\beta_1*\gamma_3*adj_{34}$	$\alpha_1*\beta_2*\gamma_3*adj_{35}$	$\alpha_1*\beta_3*\gamma_3*adj_{36}$
Highest	Other Marital & No Roommates	$\alpha_4*\beta_1*\gamma_4*adj_{37}$	$\alpha_4*\beta_2*\gamma_4*adj_{38}$	$\alpha_4*\beta_3*\gamma_4*adj_{39}$
Highest	Other Marital & Has Roommates	$\alpha_2*\beta_1*\gamma_4*adj_{40}$	$\alpha_2*\beta_2*\gamma_4*adj_{41}$	$\alpha_2*\beta_3*\gamma_4*adj_{42}$
Highest	MSA & No Roommates	$\alpha_3*\beta_1*\gamma_4*adj_{43}$	$\alpha_3*\beta_2*\gamma_4*adj_{44}$	$\alpha_3*\beta_3*\gamma_4*adj_{45}$
Highest	MSA & Has Roommates	$\alpha_1*\beta_1*\gamma_4*$ adj_{46}	$\alpha_1*\beta_2*\gamma_4*adj_{47}$	$\alpha_1*\beta_3*\gamma_4*adj_{48}$

Table 12 shows the coefficients used to calculate each remittance rate for each combination of demographics for the revised model. We calibrated the remittance rates to the 2008 aggregate remittance numbers published previously by BEA. Those calibration factors are designated as 'adj'. The precise adjustment factors vary, but most of them are approximately 3%. The point estimates are given in Table 2 of the paper.