

The Impact of Hurricane Maria: The US Census Bureau's experience combining Survey-Based Estimates and "Big Data" to Produce 2018 Puerto Rico Net Migration Estimates

Jason Schachter, Chief, Net International Migration Branch
Antonio Bruce, Population Evaluation Analysis and Projections
UNSD/UNESCAP Regional Workshop on International Migration
Bangkok, Thailand
February 2019

The Commonwealth of Puerto Rico



Puerto Rico Background

- The Commonwealth of Puerto Rico is an unincorporated territory of the United States, located in the northeast Caribbean Sea, 1,600 km from Miami, Florida.
- Population of over 3 million persons, declining since 2004.
- Puerto Ricans are US Citizens and have the right to free movement between Puerto Rico and the United States.
 - However, the US Census Bureau estimates program does not include this movement as part of its domestic migration estimates, but rather as part of its net international migration component

Big Data Background

- There has been a fair amount of research into the application of “big data” to measure international migration in recent years.
 - Social Media (Facebook, Twitter, etc.),
 - Cell phone usage (commuting)
 - Advertising data
 - Flight Data (tourism)
 - Other commercial data
- Issues of coverage, measurement, accuracy, cost/access, privacy, cost, etc., ...just to name a few.

Hurricane Background

- On September 20, 2017 Hurricane Maria, a Category 4 hurricane, devastated Puerto Rico, resulting in mass out-migration, primarily to the United States.
- Initial reports varied on the potential “exodus” to the United States.
 - Puerto Rico Governor Ricardo Rossello: “...you will see thousands, if not millions, of Puerto Ricans flocking to the United States.”
 - “It will be a massive exodus,” predicts Edwin Meléndez, an economist, professor of urban affairs, and director of the Center for Puerto Rican Studies at Hunter College. “We’re talking about 100,000 to 200,00 people.”
 - According to the Florida Division of Emergency Management, over 208,000 people from Puerto Rico landed at airports in Miami, Orlando, and Tampa since October 3rd (NBC News, November 30, 2017).

Other Studies

- These early estimates did not account for potential return migration to Puerto Rico.
- Other studies¹ also indicate that a sizeable number of Puerto Ricans (approximately 225,000 to 238,000) left for the U.S. mainland.
- These same sources indicate roughly 135,000 to 145,000 Puerto Ricans returned to the island after Hurricane Maria.
- This accounted for a net out-migration of approximately 90,000 to 93,000.

1- The PEW Research Center, [Jens Manuel Krogstad](#), 2017 - “Puerto Ricans leave in record numbers for mainland U.S.”; [Stefan Rayer](#), 2018 – “Hurricane-Induced Migration”

ACS/PRCS

- The US Census Bureau Estimates program uses the American Community Survey (ACS) to measure migration from Puerto Rico to the United States and the Puerto Rico Community Survey (PRCS) to measure migration from the United States to Puerto Rico.
- ACS: a monthly survey with a sample of 3.5 million addresses during the year.
- PRCS: monthly survey of 36,000 housing units across every municipio.
 - 1-year (national) and 5-year (subnational) files available for both.
 - Both ask the same questions, including “where did this person live one year ago,” which is the basis for the migration estimates.

How did Hurricane Maria impact the 2017 ACS/PRCS?

- The PRCS ceased operation from October-December 2017, and did not resume until January 2018.
- ACS did not adjust the weighting procedure for the 2017 ACS/PRCS to account for Hurricane Maria's impact.
 - Vintage 2017 controls were used to adjust the year 2017 ACS/PRCS estimates and the nine months were used for the full estimate year.
- This will impact PRCS estimates of “in-migration” to Puerto Rico, which will be extrapolated from the 9-month period to reflect the full year (likely overestimating in-migration to Puerto Rico, which would have been minimal from Oct-Dec).
- Analysis of monthly ACS data did not show a large influx of “in-migration” to the U.S. from Puerto Rico from September-December, thus it is likely the ACS was not picking up hurricane-related migration flows.

Why we should adjust the 2017 ACS/PRCS estimates to account for Hurricane Maria

- For Puerto Rico, this decade's net migration estimates have been based on the ACS/PRCS, but 2017 ACS data do not reflect hurricane-related movement.
- Empirical reasons why we should adjust 2017 ACS/PRCS estimates to account for Hurricane Maria's impact:
 - In 2016, ACS/PRCS estimated an out-migration of 88,000 people from Puerto Rico to the U.S., while 21,000 returned to the island from U.S., resulting a net loss of **-67,000** people.
 - The 2017 ACS/PRCS estimated an out-migration of 97,000 people from Puerto Rico to the U.S., while 20,000 returned to the island from the U.S., resulting a net loss of **-77,000** people.
 - This was a change of **10,000** or **(15.0%)** between year 2016 and 2017.

Why we should adjust the 2017 ACS/PRCS estimates to account for Hurricane Maria, cont.

- The change above does not reflect the impact of Hurricane Maria and the mass exodus of people leaving the island for the U.S. mainland.
- The ACS/PRCS was not designed to pick up these sort of sudden mass movements, because ACS and survey-based migration tends to “lag” actual migration events. Thus the ACS is not an adequate measure of net migration between the U.S. and Puerto Rico for vintage 2018.

Alternative Data Source

Airline Passenger Traffic (APT) Domestic Data¹

- Commercial flight data provided by airports/airlines to the Bureau of Transportation Statistics (BTS)
- Provides data on monthly movements between Puerto Rico and the United States
- Release of APT data lags at least 2 months and is updated with later releases
- 2018 APT data for May was scheduled for release in July, and for June in August. As of November 2018, only April 2018 data were available.

APT Data

- APT data includes all travelers (migrants, visitors, tourists)
- The APT can only provide an estimate of “net” migration
 - Only viable as a potential data source because Puerto Rico is an island without any land borders (movement via ship is minimal)
- Monthly tallies of net migration reflect seasonal patterns due to tourism
 - Year-to-year fluctuations in tourism trends could impact results if fluctuations occurred over two time periods of measurement
- As will be seen, APT data did a better job of measuring net migration to and from Puerto Rico after Hurricane Maria than the ACS/PRCS
 - Used APT data to adjust ACS/PRCS net migration estimates

Monthly APT Net Movement for Calendar Years: 2015 -2018

| Monthly APT Net Movement | 2015 | 2016 | 2017 | 2018 |
|--------------------------|----------|----------|----------|--------|
| Total Net | -122,084 | -108,693 | -301,304 | 74,166 |
| January | -11,663 | -15,749 | -19,817 | 66,321 |
| February | -2,931 | -8,956 | 3,228 | 14,128 |
| March | -20,427 | -10,452 | -10,566 | 1,981 |
| April | -31,010 | -28,798 | -29,671 | -8,264 |
| May | -28,130 | -36,394 | -24,606 | |
| June | -7,266 | 1,624 | 8,287 | |
| July | -2 | -1,736 | -3,436 | |
| August | -34,542 | -21,861 | -28,766 | |
| September | -18,014 | -15,816 | -43,144 | |
| October | 2,005 | -6,346 | -93,177 | |
| November | -5,398 | 1,227 | -43,626 | |
| December | 35,294 | 34,564 | -16,010 | |

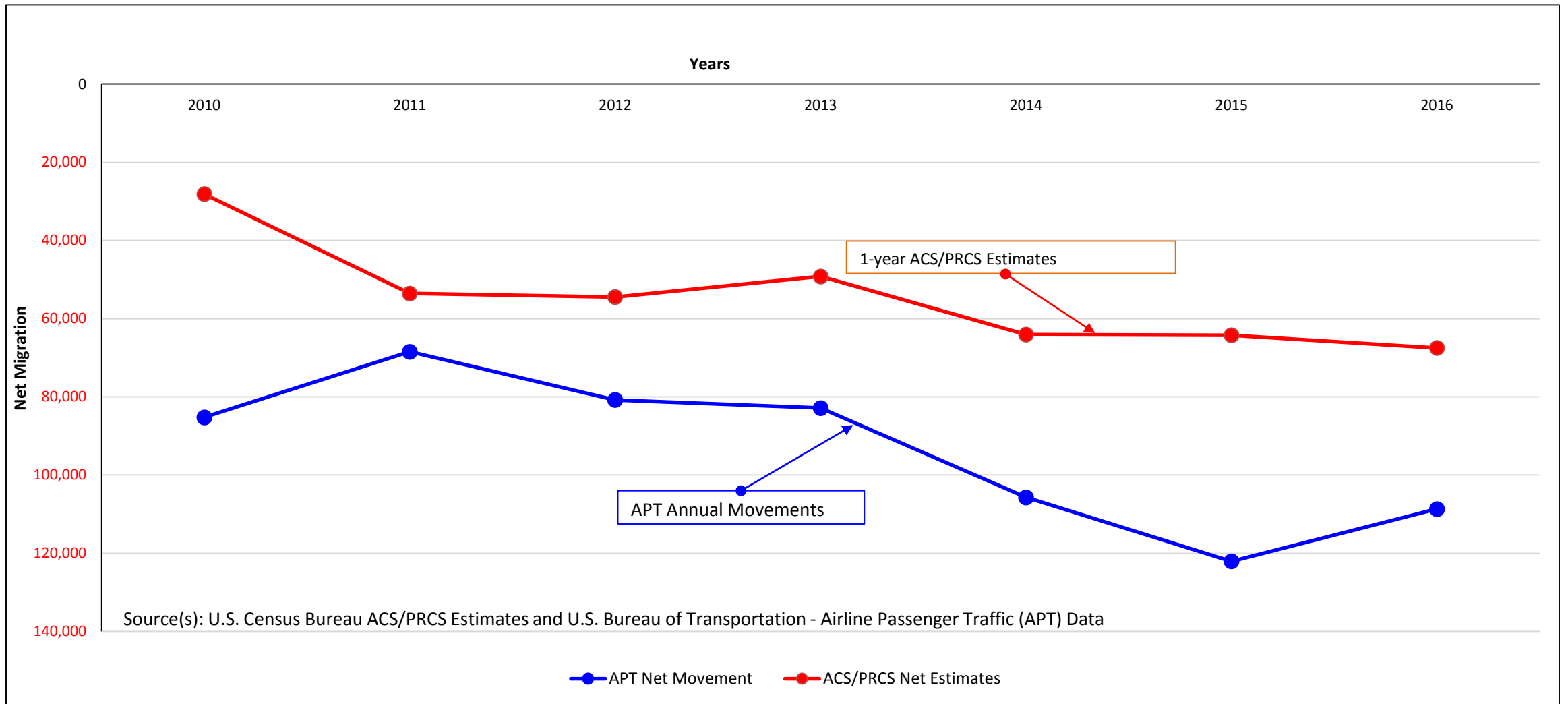
Results from APT Data

- APT data seems to better reflect the impact of Hurricane Maria on movement to and from Puerto Rico.
- We saw a large spike of Puerto Ricans flying to the U.S. during the latter months of 2017 (September-December), resulting in large net out migration.
- There was a corresponding return of Puerto Ricans from the United States in the early months of 2018, reflecting return migration .
- However, this return movement (Puerto Ricans returning to Puerto Rico from the U.S.) dropped during the early months of 2018, returning to net outmigration in April 2018.

Comparison of APT and ACS/PCRS Flows

| Annual Migration Movement | Air Passenger Traffic Data US/PR Domestic Movement | | | 1-year ACS/PCRS Estimates Migration Distribution | | |
|---------------------------|---|-----------|----------|---|--------|---------|
| | Ins | Outs | Net | Ins | Outs | Net |
| Years | | | | | | |
| 2010 | 3,700,263 | 3,785,500 | -85,237 | 31,732 | 59,885 | -28,153 |
| 2011 | 3,534,030 | 3,602,480 | -68,450 | 22,649 | 76,218 | -53,569 |
| 2012 | 3,672,341 | 3,753,135 | -80,794 | 20,044 | 74,500 | -54,456 |
| 2013 | 3,665,767 | 3,748,616 | -82,849 | 24,652 | 73,846 | -49,194 |
| 2014 | 3,702,073 | 3,807,775 | -105,702 | 19,771 | 83,844 | -64,073 |
| 2015 | 3,785,132 | 3,907,216 | -122,084 | 24,762 | 89,000 | -64,238 |
| 2016 | 3,951,359 | 4,060,052 | -108,693 | 21,196 | 88,676 | -67,480 |
| 2017 | 3,611,199 | 3,912,503 | -301,304 | 20,167 | 97,488 | -77,321 |

Net Puerto Rico to U.S. Migration: 2010-2016



Historical differences between ACS and APT net flows

- APT data has shown higher net outmigration than ACS for all years.
- Converged in 2011, but differences remain for all years since, following similar trends.
- Often find differences between survey and administrative based migration data.
 - Likely due to an inherent differences between administrative and survey-based data: coverage, volume of movement, flight data at time of move/survey data a retrospective/post facto measure of movement
 - More research needed to better understand these differences
- Used APT data to adjust 2017 ACS/PRCS estimates, to reflect changes based on the impact of Hurricane Maria.

Methodology

- Data sources: 2015-2017 1-year ACS/PRCS net migration estimates and 2015-2018 APT flight data.
 - While ACS data are only available for 2017, obtained most recent APT data for 2018 to reflect Puerto Ricans returning to the Island.
- For APT data, use the same time period as ACS (calendar year).
- As seen, APT net migration estimates have been consistently higher than ACS/PRCS estimates, perhaps because APT includes all travelers, both migrants, visitors and tourists.
 - Include only domestic movement between Puerto Rico and the U.S.
- “Blend” the ACS/PRCS and APT to adjust APT data to reflect past ACS/PRCS to APT trends.

Methodology, cont.

Ratio Method

- Calculate a ratio of ACS/PRCS to APT results for net migration over two years: 2015 and 2016.
- This ratio was applied to APT net Puerto Rico-U.S. migration measured for calendar year 2017.
- The idea behind the ratio method is to remain as methodologically consistent as possible with previous ACS/PRCS-based estimates.

ACS/PRCS Net Migration Estimates for Years 2015 - 2017

ACS/PRCS Estimates

| ACS/PRCS Net Estimates | 2015 | 2016 | 2017 | 2017 adjusted |
|---------------------------|---------|---------|---------|------------------|
| Total Net | -64,238 | -67,480 | -77,321 | -172,799 |

Ratio Method of ACS/PRCS to APT for Years: 2015 - 2017

| Net Migration | 2015 | 2016 | 2017 |
|---------------|-----------------|----------|----------|
| ACS/PRCS | -64,238 | -67,480 | -77,321 |
| APT | -122,084 | -108,693 | -301,304 |
| Ratio | .52618 | .62083 | |
| Avg. Ratio | .5735049 | | |

Ratio Method Results

- The ACS/PRCS measured **-77,321** net migrants for the year 2017, not reflecting the impact of Hurricane Maria.
- The APT measured **-301,304** net migrants during the calendar year 2017, with **-195,957** from the months of September to December, reflecting post-Maria outmigration from Puerto Rico to the U.S.
- ACS/PRCS net migration results were 0.5735 lower than the APT during the same two-year period of 2015 and 2016.
- To get an equivalent ACS/PRCS figure for 2017, the APT number is multiplied by the .5735 ratio to yield a figure of **-172,799** persons.
- This is equivalent to applying 2017 ACS/PRCS data to the vintage 2018 estimate year, thus consistent with the methodology for previous net migration estimates for Puerto Rico.

Final Adjustment to Ratio Method

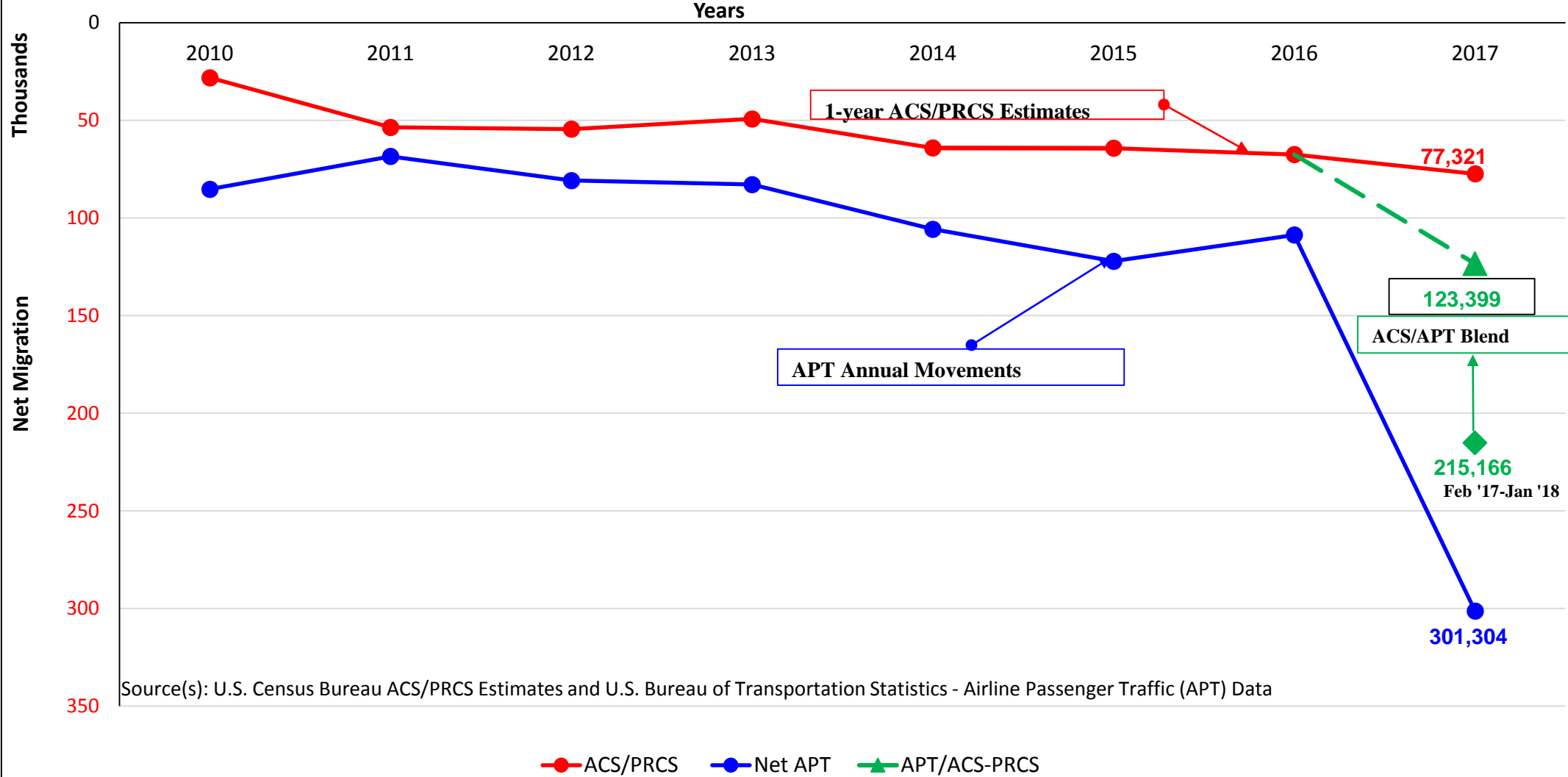
- Starting in 2018, APT data show large numbers of return migrants, particularly in January, slowing down in February, and returning to negative in April.
- The PR net migration estimate is supposed to represent July 1, 2018 (while ACS/PRCS migration flow data represents calendar year 2017).
- We further adjusted the methodology as follows:
 - In order to account for the January return migration, we used the APT time-period from Feb 2017 to Jan 2018, prior to applying our two-year ratio to make it ACS equivalent.
 - Shifting our time period one month helped account for return migrants, yet keep most months (11 of 12) within the ACS/PRCS-equivalent calendar year.

Final Ratio Method Result

- This modification yields **-215,166** in net APT migration, which when adjusted by the ACS ratio, yields a final figure of **-123,399** net migration from Puerto Rico to the United States.
- This method takes APT data for an approximately same time period as the ACS (shifted one month), adjusts this figure as if it were the ACS based on trends over the past two years (as if the ACS were able to measure this sudden migration), and also accounts for return migration early in the year.

Fig. 1

Net Puerto Rico to U.S. Migration: 2010-2017



Source(s): U.S. Census Bureau ACS/PRCS Estimates and U.S. Bureau of Transportation Statistics - Airline Passenger Traffic (APT) Data

Future Work

- Continue to monitor potential return migration to Puerto Rico.
- Determine the viability of replacing ACS net migration estimates with APT-based estimates.
 - Better understanding of APT data and why differs from ACS estimates
- Modeling and/or integration of APT and ACS/PRCS data to calculate more robust estimates.