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**Article**

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*Currently, Devereux is a senior adviser at the Globalization and Monetary Policy Institute of the Federal Reserve Bank of Dallas and a Research Fellow at the Center for Economic Policy Research in London. In 2014 he completed a three-year term as the first director of the Vancouver School of Economics at the University of British Columbia.*

*From 2003-13, Devereux was a Bank of Canada Research Fellow. He has had visiting positions at University College Dublin, the Hong Kong Institute for Monetary Research, the Hong Kong University of Science and Technology, the International Monetary Fund, and the Bank for International Settlements. He was the recipient of the 2010 John Rea Prize from the Canadian Economic Association for the economist with the best five-year track record in Canada.*

*He has a Ph.D. from Queen's University in Kingston, Ontario, and has held positions at the University of Toronto and Queen's University.*

## Real Exchange Rates and the Balassa-Samuelson Effect Revisited

**Michael B. Devereux**

It has long been acknowledged that prices of consumer goods differ substantially across countries, and vary considerably between any two countries over time. In the aggregate, relative goods-prices compared across countries are defined as real exchange rates. Understanding real exchange rate determination remains one of the most important and yet most difficult questions in international economics.

The central theoretical framework for interpreting real exchange rates attributes persistent movements in real exchange rates over time and across countries to cross-country differentials in sectoral total-factor productivities. This is known as the Balassa-Samuelson model.<sup>1</sup> The forces that drive this model are straightforward; higher productivity growth in traded-goods sectors tends to increase local input costs and therefore prices of non-tradable goods. Since traded-goods prices tend to be equalized across countries, this raises the local price level, which is a real exchange rate appreciation.

The Balassa-Samuelson model has been widely used in analyzing real exchange rate determination. One reason for its popularity is that it is consistent with the widespread observation that price levels tend to be higher in comparatively wealthy countries. There is a strong positive relationship between price levels and GDP per capita. This is sometimes known as the “Penn effect,” after the two University of Pennsylvania economists, Alan Heston and Robert Summers, who first documented it.<sup>2</sup>

Despite the simplicity and appeal of the theory, it is widely acknowledged that the Balassa-Samuelson model does not do well in explaining real exchange rates, except over very long time horizons.<sup>3</sup> In most empirical studies, especially in time-series data, the evidence for the effect of productivity growth on real exchange rates is quite weak. This problem is especially apparent in the study of real exchange rate movements among high-income, finan-

cially developed countries with floating exchange rates.

This short review essay describes my research agenda on real exchange rate determination, the Penn effect, and the Balassa-Samuelson theory, using a new data set of European price levels at a disaggregated level. In an initial paper, Martin Berka and I established that the Penn effect is clearly observed among European Union countries, both in cross-section and time series, and that this relationship is tied closely to trend movements in relative non-traded goods prices.<sup>4</sup> In a second paper, Charles Engel, Berka, and I find strong evidence for an amended version of the Balassa-Samuelson model in an application to countries within the Eurozone.<sup>5</sup>

There is a large literature on the explanation of secular movements in real exchange rates and the Balassa-Samuelson effect. As noted above, a prediction of many theoretical models is that the cross-country distribution of real exchange rates should be related to relative GDP per capita. Kenneth Rogoff, for example, uses relative GDP per capita as a proxy for relative productivity in the traded sector.<sup>6</sup> In cross-sectional 1990 data that includes poor and rich countries, he finds a strong relationship between relative GDP per capita and the real exchange rate.<sup>7</sup> However, Rogoff then notes “...whereas the relationship between income and prices is quite striking over the full data set, it is far less impressive when one looks either at the rich (industrialized) countries as a group, or at developing countries as a group.” In particular, among high-income countries with floating exchange rates, there is little evidence of a relationship between GDP per capita and the real exchange rate.

The Balassa-Samuelson theory suggests real exchange rates should be related to sectoral total-factor productivity (TFP) rather than income levels per se. There are few studies that examine the cross-sectional dimension of the Balassa-Samuelson hypothesis

using sectoral data on TFP, because most TFP data that is used for cross-country comparisons is in index form and is only useful for looking at the time-series dimension. But the evidence favorable to the Balassa-Samuelson effect is much weaker in time-series. In fact, even the basic prediction of the Balassa-Samuelson model needs to be refined when traded goods in different countries are not perfect substitutes for one another.<sup>8</sup> In that case, the relationship between the real exchange rate and relative productivity differentials should be conditioned on the terms of trade. A novel aspect of my work with Berka and Engel is that it shows that the inclusion of unit labor costs, in a real exchange rate regression, in addition to relative sectoral productivities, acts as a proxy for the terms of trade and represents a well-specified structural representation of the real exchange rate, even when home and foreign-traded goods are not perfect substitutes.

A notable finding of some of the literature on real exchange rates is that there is often stronger evidence of the effect of relative sectoral productivity on a country's internal relative prices than can be found in between-country real exchange rates.<sup>9</sup> This may be due to the presence of nominal exchange rate fluctuations that have little to do with relative productivity differentials. Again, this suggests to us that a focus on real exchange rate determination in a sample where nominal exchange rate movement is absent or minimized may be a fruitful avenue of investigation.

My paper with Berka examines the behavior of real exchange rates, both at aggregate and disaggregate levels, across a large sample of European countries over a 15-year period ending in 2009.<sup>10</sup> The price data is very broad, encompassing almost the whole consumer basket, and it has an extremely high degree of cross-country comparability. The sample allows for construction of a panel of real exchange rates at the sectoral and aggregate level over the period 1995–2009. Since the data is in levels, we can construct a real exchange rate distribution across countries at any point in time and track the movement of this distribution over time.

We find large and persistent deviations

from absolute PPP among all European countries. These deviations hold for all categories of goods, but are much more pronounced for non-traded than for traded goods. Even among Eurozone members, there are persistent departures from PPP that show no signs of erosion within the sample. A striking feature of real exchange rates in the data is that they are highly positively correlated with the internal relative price of non-traded to traded goods. This relationship holds true both across countries and over time. Over the whole sample, the cross-country correlation between the real exchange rate and the relative price of non-traded goods is 0.89, while the time series correlation is 0.84.

We also find that there is a highly positive correlation between deviations from PPP in traded goods prices, and the internal relative price of non-traded goods, again both among countries and over time. This suggests that non-traded inputs into retail prices of traded goods may play an important role in deviations from PPP in the traded goods category. Finally, we find striking evidence for the “Penn effect;” real exchange rates are very closely tied to GDP per capita relative to the European average, again *both* in comparisons across countries and in movement over time. It is quite striking that this pattern holds, even though the per-capita GDP differential among European countries is of far smaller magnitude than among developed and developing countries. What this suggests is that for European countries, the relative stability of bilateral nominal exchange rates may have been important in allowing for a more fundamental-based evolution of real exchange rates, in contrast to the findings from a wider sample of countries where nominal exchange rate variation becomes a much more important element.

My paper with Berka and Engel builds on this study, using a similar data-set, but focusing on the underlying determinants of real exchange rates, and providing a more direct test of the Balassa-Samuelson theory of real exchange rates using sectoral data on prices to construct model-based real exchange rates and linking these with sectoral data on productiv-

ity growth.<sup>11</sup> We restrict our focus to the properties of real exchange rates in the Eurozone, where bilateral nominal exchange rates are fixed.<sup>12</sup> The reason for the restriction was our conjecture that this would allow for a cleaner examination of the relationship between productivity growth and relative-price adjustment. It is well known from the literature on open-economy macroeconomics that floating nominal exchange rates are influenced by monetary policy decisions and shocks, financial shocks, and quite possibly also by non-fundamental shocks. When nominal prices adjust more slowly than the nominal exchange rate, these shocks also influence the real exchange rate. In light of this, it is likely that the observation of real exchange rates among countries that share a common currency is fertile ground for seeking evidence of the Balassa-Samuelson effect because the short-run real exchange rate movements are not driven by the monetary and financial factors that influence nominal exchange rates.

We link a panel of Eurozone real exchange rates with measures of sectoral total-factor productivities for each country, as well as a separate measure of unit labor costs. We then conduct panel regressions of real exchange rates to explore the link between real exchange rates and productivity. The empirical results indicate that, for the Eurozone countries, there is substantial evidence for an amended Balassa-Samuelson effect. The amended Balassa-Samuelson model involves allowing for unit labor costs as a separate variable affecting real exchange rates, independent of sectoral total-factor productivity. As described above, unit labor cost plays a dual role as a proxy for endogenous movements in the terms of trade and separate exogenous shifts in labor market conditions that are not related to total-factor productivity.

We find that an increase in total-factor productivity in traded goods is associated with a real appreciation, and an increase in total-factor productivity in non-traded goods correlates with a real depreciation. But these links appear only when they separately control for unit labor cost differentials across countries. Holding productiv-

ity constant, higher unit labor costs lead to real exchange rate appreciation. This suggests that in fact there are separate institutional forces driving factor prices, independent of factor productivities.

We then develop a theoretical model of an amended Balassa-Samuelson theory by allowing for shocks to labor supply that are unrelated to productivity. Differences in unit labor costs may influence real exchange rates both through their effects on the relative prices of non-traded goods and also the terms of trade. We examine the implications of the model for the Balassa-Samuelson theory when nominal exchange rates are not volatile, since the countries share a common currency, but nominal prices are sticky. We use the model to generate a panel of real exchange rate levels and movements over time which matches the European panel for the Eurozone countries. Using the same cross-section and time-series dimensions as the data, the model is simulated using shocks to sectoral productivities and labor supply shocks. The sectoral productivity shocks in the model are generated in a model-based panel which has the same means, serial correlation, and covariance matrix as in the European data. Shocks to labor supply, which in addition to the productivity shocks underlie the dynamics of unit labor costs in the model, are inferred from relative movements in hourly wages observed over the sample period.

We find a close relationship between the empirical estimates and the model-simulated estimates. Real exchange rates in the model are driven by the amended Balassa-Samuelson pattern of shocks to sectoral productivity and unit labor costs, and the simulation estimates are extremely close to those in the Eurozone data. The sticky price version of the model, where 20 percent of prices change every quarter, best explains the empirical estimates. Although a fully flexible price version of our model does quite a good job in explaining the empirical results, it tends to predict movements in real exchange rates in response to traded-sector productivity and unit labor costs that are too large relative to the empirical estimates.

The channel through which rela-

tive productivity levels influence real exchange rates is their effect on the relative price of non-traded goods. In previous work, Engel produces evidence that little of the variance of changes in U.S. real exchange rates can be accounted for by the relative price of non-traded goods.<sup>13</sup> Almost all of the variance arises from movements in the consumer prices of traded goods in the U.S. relative to other countries. Several studies suggest that differences in consumer prices of traded goods across countries may be accounted for by changes in the relative price of non-traded distribution services, but the evidence for this hypothesis is weak for high-income countries.<sup>14</sup> However, the seminal paper by Michael Mussa pointed out that real exchange rates are much less volatile among countries with fixed nominal exchange rates.<sup>15</sup> So the absence of fluctuating exchange rates in the Eurozone suggests a possible reason that the real exchange rate/non-traded goods link becomes apparent in our data.

It is important to note that the data used in these studies is disaggregate, but not micro-data on individual goods prices. A number of important recent contributions have used micro-data on individual prices from a single retailer to construct individual-goods-level real exchange rates.<sup>16</sup> One key difference between these studies and ours is that, as noted above, our price data has both broad coverage, governing almost the complete consumer basket in the Eurozone countries studied, and a very high degree of cross-country comparability. We provide an extensive data appendix, describing the construction of the data, and emphasize the extensive set of procedures that Eurostat follows to ensure that goods in each of the categories are measuring very similar products across countries.<sup>17</sup>

A second unique feature of the data we used is an annual panel of sectoral TFP levels across nine Eurozone countries. The data allow us to make cross-sectional comparisons, as well as the time comparisons, across sectors and countries. To our knowledge, this is the first time that a sectoral TFP panel in levels has been used to study real exchange rate determination

and the Balassa-Samuelson hypothesis.

It is tempting to conclude from these results that relative-price adjustment and real exchange rates within the Eurozone system have occurred efficiently, given that Balassa-Samuelson represents a benchmark model of efficient relative-price adjustment in the face of differential productivity-growth rates. But in fact this inference cannot be directly made, since our amended Balassa-Samuelson framework features movement in unit labor costs that may represent underlying distortions or structural inefficiencies within individual economies. Hence, while the results provide encouraging support for the traditional view of real exchange rates, they cannot be taken as evidence that trends in real exchange rates within the Eurozone have been consistent with efficient cross-country relative-price adjustment.

A second key caveat is that the sample period of these studies does not include the European debt crisis for 2010–12. In the face of a large crisis, it is likely that countries within a single currency area would suffer from not having the ability to adjust exchange rates.<sup>18</sup> So, again, the studies discussed above do not claim that eliminating national currencies and exchange rate adjustment is without costs. But an important agenda for future research is to see how intra-European relative-price adjustment over this episode was related to the extent of the downturns across countries and regions.<sup>19</sup>

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<sup>1</sup> See B. Balassa, “The Purchasing-power Parity Doctrine: a Reappraisal,” *Journal of Political Economy*, 72(6), 1964, pp.584–96, and P. A. Samuelson, “Theoretical Notes on Trade Problems,” *The Review of Economics and Statistics*, 46(2), 1964, pp. 145–54. [Return to text.](#)

<sup>2</sup> See for example, R. Summers and A. Heston, “The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950–1988,” *Quarterly Journal of Economics*, 106(2), 1991, pp. 327–68. *The Balassa-Samuelson model rationalizes this relationship based on technological, or supply side forces. There are alternative theories coming from pref-*



erences and demand side. For instance, J. H. Bergstrand, "Structural Determinants of Real Exchange Rates and National Price Levels: Some Empirical Evidence," *American Economic Review*, 81(1), 1991, pp. 325–34. Bergstrand argues that trend differences in average economic growth, combined with income elasticity of demand for services that exceeds unity, plays an important role in explaining the relationship. [Return to text.](#)

<sup>3</sup> M. Chinn, and L. Johnson, "Real Exchange Rate Levels, Productivity, and Demand Shocks: Evidence from a Panel of 14 Countries," NBER Working Paper No. 5709, August 1996; K. Rogoff, "The Purchasing Power Parity Puzzle," *Journal of Economic Literature*, 34(2), 1996, pp. 647–68; J. Tica, and I. Druzic, "The Harrod-Balassa-Saumelson Effect: A Survey of Empirical Evidence," *University of Zagreb Working Paper* 06-7/686, 2006; J. R. Lothian, and M. P. Taylor, "Real Exchange Rates Over the Past Two Centuries: How Important is the Harrod-Balassa-Samuelson Effect?" *The Economic Journal*, 118(532), 2008, pp. 1742–63; Y. Chong, O. Jordà, and A. M. Taylor, "The Harrod-Balassa-Samuelson Hypothesis: Real Exchange Rates and their Long-run Equilibrium," *International Economic Review*, 53(2), 2012, pp. 609–33. [Return to text.](#)

<sup>4</sup> M. Berka, and M. B. Devereux, "What Determines European Real Exchange Rates?" NBER Working Paper 15753, February 2010. [Return to text.](#)

<sup>5</sup> M. Berka, M. B. Devereux, and C. Engel, "Real Exchange Rates and Sectoral Productivity in the Eurozone," NBER Working Paper No. 20510, September 2014; see also M. Berka, M. B. Devereux, and C. Engel, "Real Exchange Rate Adjustment in and out of the Eurozone," *American Economic Review, Papers and Proceedings*, 102(3), 2012, pp. 179–85. [Return to text.](#)

<sup>6</sup> K. Rogoff, "The Purchasing Power Parity Puzzle," *Journal of Economic Literature*, 34(2), 1996, pp. 647–68. [Return to text.](#)

<sup>7</sup> P. R. Bergin, R. Glick, and A. M. Taylor note that this cross-sectional relationship has strengthened over time, and

suggest that the tradability of goods is endogenous and may increase as a sector's productivity grows. P. R. Bergin, R. Glick, and A. M. Taylor, "Productivity, Tradability, and the Long-run Price Puzzle," NBER Working Paper No. 10569, June 2004 and *Journal of Monetary Economics*, 53(8), 2006, pp. 2041–66. [Return to text.](#)

<sup>8</sup> G. Benigno, and C. Thoenissen, "Consumption and Real Exchange Rates with Incomplete Financial Markets and Non-traded Goods," *Journal of International Money and Finance*, 27(6), 2008, pp. 926–48. [Return to text.](#)

<sup>9</sup> Studies in this tradition include J. D. Gregorio, A. Giovannini, and H. C. Wolf, "International Evidence on Tradables and Nontradables Inflation," NBER Working Paper No. 4438, August 1993, and *European Economic Review*, 38(6), 1994, pp. 1225–44; M. B. Canzoneri, R. E. Cumby, and B. Diba, "Relative Labor Productivity and the Real Exchange Rate in the Long Run: Evidence from a Panel of OECD Countries," NBER Working Paper No. 5676, July 1996, and *Journal of International Economics*, 47(2), 1996, pp. 245–66; and J. Lee and M.-K. Tang, "Does Productivity Growth Lead to Appreciation of the Real Exchange Rate?" *Review of International Economics*, 94(1), 2007, pp. 276–99. [Return to text.](#)

<sup>10</sup> M. Berka, M. B. Devereux, "Trends in European Real Exchange Rates," NBER Working Paper No. 15753, February 2010, (as "What Determines European Real Exchange Rates?") and *Economic Policy*, 28(74), 2013, pp. 193–242. [Return to text.](#)

<sup>11</sup> M. Berka, M. B. Devereux, and C. Engel, "Real Exchange Rates and Sectoral Productivity in the Eurozone," NBER Working Paper No. 20510, September 2014. [Return to text.](#)

<sup>12</sup> Our sample actually includes the Eurozone countries over the period from 1995 onwards, four years before the adoption of the single currency. But during this period, bilateral exchange rate volatility among the future member countries was extremely low. [Return to text.](#)

<sup>13</sup> C. Engel, "Accounting for US Real

Exchange Rate Changes," NBER Working Paper No. 5394, December 1995, and *Journal of Political Economy*, 130(3), 1999, pp. 507–38. [Return to text.](#)

<sup>14</sup> M. B. Devereux, "Real Exchange Rate Trends and Growth: A Model of East Asia," *Review of International Economics*, 7(3), 1999, pp. 509–21; C. Engel, "Accounting for US Real Exchange Rate Changes," NBER Working Paper No. 5394, December 1995, and *Journal of Political Economy*, 130(3), 1999, pp. 507–38; A. Burstein, J. C. Neves, and S. Rebelo, "Distribution Costs and Real Exchange Rate Dynamics During Exchange-rate-based Stabilizations," NBER Working Paper No. 7862, August 2000, and *Journal of Monetary Economics*, 50(6), 2003, pp. 1189–1214; C. Betts and T. J. Kehoe, "U.S. Real Exchange Rate Fluctuations and Relative Price Fluctuations," *Journal of Monetary Economics*, 53(7), 2006, pp. 1297–1326. [Return to text.](#)

<sup>15</sup> M. Mussa, "Nominal and Real Exchange Rate Regimes and the Behavior of Real Exchange Rates: Evidence and Implications," *Carnegie-Rochester Conference Series on Public Policy*, 25, 1986, pp. 117–214. [Return to text.](#)

<sup>16</sup> M. Baxter, and A. Landry, "IKEA: Product, Pricing, and Pass-through," *Federal Reserve Bank of Dallas, Globalization and Monetary Policy Institute Working Paper* 132, 2012; A. Cavallo, B. Neiman, B. and R. Rigobon, "Currency Unions, Product Introductions and the Real Exchange Rate," *Quarterly Journal Economics*, 129(2), 2014, pp. 529–95; G. Gopinath, P.-O. Gourinchas, C.-T. Hsieh, and N. Li, "International Prices, Costs and Markup Differences," NBER Working Paper No. 14938, April 2009, (as "Estimating the Border Effect: Some New Evidence") and *American Economic Review*, 101(6), 2011, pp. 2450–86; A. Burstein, and N. Jaimovich, "Understanding Movements in Aggregate and Product-level Real Exchange Rates," Manuscript, 2009. [Return to text.](#)

<sup>17</sup> Eurostat and OECD (2012). *Eurostat-OECD Methodological Manual on Purchasing Power Parities*. ISBN: 978-92-79-25983-8, <http://>

[ec.europa.eu/eurostat/en/web/products-manuals-and-guidelines/-/KS-BE-06-002](http://ec.europa.eu/eurostat/en/web/products-manuals-and-guidelines/-/KS-BE-06-002)  
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<sup>18</sup> *Against this, however, David Cook and I note that when interest rates are constrained by the zero bound, the movement in the exchange rate in response to some shocks may exacerbate rather than mitigate*

*the effects of the shock, and it may be better in an ex-ante sense for a country to be in a common currency area. See D. Cook and M. B. Devereux, "The Optimal Currency Area in a Liquidity Trap," NBER Working Paper No. 19588, October 2013.*  
[Return to text.](#)

<sup>19</sup> *Rudolfs Bems and Julian di Giovanni*

*provide interesting evidence on price and expenditure adjustment during the recent crisis for Latvia. R. Bems and J. D. Giovanni, "Income Induced Expenditure Switching," Manuscript, 2013.*

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## NBER News

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### Four New Members Elected to NBER Board of Directors

At its September 2014 meeting, the NBER Board of Directors elected four new members.

**Benjamin Hermalin** is the new representative of the University of California, Berkeley. He succeeds **George Akerlof**, who was elected director emeritus. Hermalin holds professorships in Berkeley's Economics Department and its Haas School of Business. In the latter, he is the Thomas & Alison Schneider Distinguished Professor of Finance. He is a co-editor of the *RAND Journal of Economics*. Hermalin received his Ph.D. from MIT in 1988, the same year he joined the Berkeley faculty as an assistant professor in the Department of Economics and the School of Business. He became a full professor in 1998. He has held numerous administrative posts at Berkeley, including serving as interim dean of the Haas School for most of 2002 and as Economics Department chair from 2005 until 2008. He is currently vice chair of the Academic Senate, Berkeley Division, and will be its chair in 2015–16. His areas of research include corporate governance, the study of organizations, and industrial organization.

**Arthur Kennickell** is the new representative of the American Statistical Association (ASA), succeeding **Christopher Carroll**. He is assistant director of research and statistics at the Board of Governors of the

Federal Reserve System, where he has worked since 1984. He is the former section chief for microeconomic surveys. He has a Ph.D. in economics from the University of Pennsylvania and a B.A. from the University of Chicago. He was the 2007 winner of the Julius Shiskin Memorial Award for innovation in economic statistics. He has long been associated with the development of the Survey of Consumer Finances. Kennickell is a returning member of the NBER board, having previously served as the ASA representative to the NBER from 2004 to 2011.

**Cecilia Elena Rouse** is the new representative from Princeton University, succeeding **Uwe Reinhart**. She is the dean of the Woodrow Wilson School of Public and International Affairs and the Lawrence and Shirley Katzman and Lewis and Anna Ernst Professor in the Economics of Education. She is the founding director of the Princeton University Education Research Section and a member of the National Academy of Education. Her primary research interests are in labor economics with a focus on the economics of education. Rouse has served as an editor of the *Journal of Labor Economics* and is currently a senior editor of *The Future of Children*. In 1998–99 she served a year in the White House at the National Economic Council and from 2009–

11 was a member of the President's Council of Economic Advisers. She is a member of the board of directors of MDRC, and a director of the T. Rowe Price Equity Mutual Funds and T. Rowe Price Fixed Income Mutual Funds. She received her B.A. in economics from Harvard University in 1986 and a Ph.D. in economics from Harvard University in 1992.

**William Spriggs** is the new AFL-CIO representative on the NBER board, succeeding **Thea Lee**. He is a professor in, and former chair of, the Department of Economics at Howard University and serves as chief economist to the AFL-CIO. He chairs the Economic Policy Working Group for the OECD's Trade Union Advisory Committee. From 2009 until 2012, he served as the assistant secretary for the Office of Policy at the U.S. Department of Labor. He has served as chairman of the Healthcare Trust for the UAW retirees of the Ford Motor Company and as a senior fellow and economist at the Economic Policy Institute, and has worked on the economic staff of the Joint Economic Committee. Spriggs graduated from Williams College and holds a Ph.D. in economics from the University of Wisconsin, Madison. He is a former president of the National Economics Association, the organization of America's professional black economists.