Exhibit No.:
Witness: Joseph H. Haslag
Type of Exhibit: Direct Testimony
Issues: Noranda Economic Impact
Sponsoring Party: Noranda Aluminum, Inc.
Case No.: _____

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of Noranda Aluminum, Inc.'s Request for Revisions to Union Electric Company d/b/a Ameren Missouri's Large Transmission Service Tariff to Decrease its Rate for Electric Service	)	**Case No. _____**

Direct Testimony of Joseph H. Haslag

(NP VERSION)

On behalf of

Noranda Aluminum, Inc.

January 25, 2014

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of Noranda Aluminum, Inc.'s Request for Revisions to Union Electric Company d/b/a Ameren Missouri's Large Transmission Service Tariff to Decrease its Rate for Electric Service	)	Case No. _____

STATE OF MISSOURI)
) SS
COUNTY OF BOONE)

Affidavit of Joseph H. Haslag

Joseph H. Haslag, being first duly sworn, on his oath states:

1. My name is Joseph H. Haslag. I am a professor in Economics at the University of Missouri. My business address is Department of Economics, University of Missouri, Columbia, Missouri 65211.

2. Attached hereto and made a part hereof for all purposes is my direct testimony, which was prepared in written form for introduction into evidence in Missouri Public Service Commission Case No. _____.

3. I hereby swear and affirm that the testimony is true and correct.

Joseph H. Haslag

Subscribed and sworn to before me this 25 day of January, 2014.

Susan Ripley
Notary Public

SUSAN RIPLEY
Notary Public - Notary Seal
STATE OF MISSOURI
County of Boone
My Commission Expires 12/15/2015
Commission # 11498188

Before the
Missouri Public Service Commission

Case No. _____

Prepared Direct Testimony of Joseph H. Haslag

Q: Please state your name and business address.

A: Joseph H. Haslag; Department of Economics, University of Missouri, Columbia, MO 65211.

Q: What is your occupation, where are you employed and how long have you held your current position?

A: I am a professor in Economics at the University of Missouri. I have been in my current position for thirteen years.

Q: Please summarize your educational background and experience.

A: I was conferred a PhD in Economics from Southern Methodist University. I served as an economist in the Research Department at the Federal Reserve Bank of St. Louis and Dallas. I was adjunct faculty at Southern Methodist University from 1988 through 2000, and faculty at the University of Missouri since 2000. I attach my vita hereto. It is current and accurate.

Summary and Conclusions

Q: What is the purpose of your testimony?

A: The purpose of my testimony is to explain the impact that Noranda's New Madrid Smelter has on the economy of the state of Missouri. Other witnesses will explain the impact of Ameren Missouri's electric rates on Noranda and the potential they have to cause the closure of Noranda's Smelter. My testimony is provided to assist the Commission in understanding the consequences to Missouri's economy that would result from a closure of Noranda's New Madrid Smelter.

Q: Please explain your approach to measuring the impact of the closing of Noranda's Smelter on Missouri's economy.

A: I have quantified the impact of closing Noranda's Smelter in terms of the effect on the value of final goods and services produced within Missouri's borders each year; that is, Missouri's state Gross Domestic Product (GDP). In addition, I have computed the effect on state and local government tax collections that arise from the shrunken tax base, and on the expected unemployment insurance payments arising because of layoffs.

Q: What facts have you relied on in preparing your testimony, and what is the source of that information?

A: According to Noranda CEO Kip Smith:

> Noranda is an integrated aluminum manufacturer. The manufacturing of aluminum is an energy-intensive and capital-intensive commodity business.

In addition to its smelter near New Madrid, Missouri, Noranda owns and operates a bauxite mine in Jamaica and an alumina refinery in Gramercy, Louisiana. The New Madrid Smelter produces molten aluminum and converts molten aluminum to aluminum products such as billet, rod, foundry products and primary ingots. The smelter has been operating in Southeast Missouri since February 25, 1971. Its primary product inputs are electricity and alumina. The alumina is delivered via barge over the Mississippi River. Alumina, also known as aluminum oxide, is produced from bauxite ore. The New Madrid Smelter processes the alumina through three production lines that electrolytically convert aluminum oxide into molten aluminum. The process requires an unusually large amount of electricity. On an annual basis, the New Madrid Smelter purchases about the same amount of electricity as the entire city of Springfield, MO. Electricity must also be constantly available to the production lines, otherwise the lines will be damaged from liquid metal solidifying in the lines. When at full production, the smelter produces more than 260,000 metric tons of aluminum per year. The aluminum is sold primarily in North America. Noranda is one of the largest foil producers in North America and a major producer of light gauge sheet products.

Noranda has supplied data on production of aluminum and on market prices at which aluminum is sold. My testimony is based on the data provided by Noranda.

The economic modeling and the calculations described below are solely my determinations.

Q: How would you summarize your conclusions?

A: Overall, the New Madrid smelting facility, operated by Noranda, has a large economic impact compared to typical business operations in Missouri. It employs a large number of people and has valuable equipment utilized to smelt aluminum. It is my conclusion that the three main economic impacts of the closing of Noranda's New Madrid Smelter would be:

1. GDP Loss

Over a generation, the impact that the New Madrid facility has on the Missouri economy is, after discounting, computed to be $8.917 billion over the next 25 years. Over the next ten years, the loss in real GDP to the Missouri economy is $3.646 billion. In other words, Missouri's economy would forego nearly $9 billion in economic activity if the Noranda Smelter were closed.

2. State and Local Taxes

State and local tax collections would be affected. At the state level, net general revenue funds over the next twenty-five years, after discounting, would be $338.87 million lower if the Noranda Smelter closed permanently compared with an economic projection in which the Noranda physical capital is fully utilized. Over the ten-year period, the present value of lost net general revenue funds is $138.55

million. In addition, local taxes will be affected. By closing the Noranda Smelter, the local property tax base would shrink. By my estimates, the present value of the local property receipts would be reduced by $51.45 million if the lost revenue from Noranda is not made up by increased collections on remaining taxpayers. Over the next ten years, the value of the local property receipts would be reduced by $20.24 million, provided the lost taxes paid by Noranda are not made up by increased collections from remaining taxpayers. When the tax base shrinks, the tax burden is frequently reallocated to remaining taxpayers. So, property taxes burdens are redistributed to citizens, thereby harming them by reducing their personal expenditures.

3. Unemployment Insurance Benefits

Were the Noranda Smelter to shut down, layoffs would result. There are 888 employees at the New Madrid Smelter. Between now **_____** when the smelter is subject to completely shutting down, the expected value of unemployment insurance benefits paid by the State of Missouri is at least $2.7 million. The $2.7 million value is based on the long-run average value for unemployment spells. Note that if we take current business cycle conditions into account, the expected unemployment spell would be longer. At present, the length of the unemployment is higher than the long-run average. Indeed, unemployment insurance benefits paid to Missouri residents could be as high as $10.3 million under the current rules governing unemployment insurance benefits.

Q: Are your conclusions based on generally accepted economic theory?

A: Yes. Economic theory provides the basis for my calculations. I follow the *Ak* growth model developed by Rebelo (1991) and implemented by Ireland (1996) to compute the effect that the reduction in the factor inputs—people, machines, and equipment—would have on the Missouri economy. The basic idea is that physical capital and human capital are combined to produce goods and services. The value of those goods and services is what is known as Gross Domestic Product (GDP). Here, I focus on the measure of GDP at the state level.

Analysis

Q: What mathematical formula did you use to calculate the effect of Noranda's Smelter on Missouri's Gross Domestic Product?

A: Formally, the production of final goods and services produced within Missouri's boundaries is represented by the function

$$Y_t = Ak_t \qquad \text{(equation (1))}$$

where *Y* stands for Missouri's GDP for a year indexed by *t*, *k* the quantity of human and physical capital employed at date *t*, and *A* is the technology that represents the rate at which human and physical capital are transformed into units of final goods and services.

This equation serves as the basis for computing the effect that Noranda's New Madrid Smelter has on the Missouri economy. Here, there is a market value of the

smelter's physical and human capital. If the smelter shuts down, there is an immediate impact on the value of goods and services produced in Missouri. This shock to the Missouri economy is captured by an immediate reduction in the state's GDP.

Over time, there are changes to the Missouri economy that occur because of the smelter closure. This model explicitly deals with changes occurring over time. You can see this explicitly in equation (1) by the fact that output and the capital input both have time subscripts. Equation (1) represents the relationship between output and the capital input at a particular date. In other words, output is measured *at a point in time*, which is typically a year. As the time subscripts change, the model economy is capturing how Missouri's GDP evolves over time. For example, the *Ak* model allows for the Missouri economy, on average, to grow over time. With this growth feature in the model economy, I can conduct the following experiment. Specifically, I can compute the evolution of the Missouri economy over time, with and without production at Noranda's New Madrid Smelter.

Q: Does this model take into account changes to Missouri's economy over time?

A: Yes. Since the changes impact the Missouri economy over time, this model explicitly deals with the time domain. Indeed, the time subscript (represented by the small *t* in the equation) identifies the relationship between human and physical capital and GDP *at a point in time.* By allowing the time period to change, the

model economy allows for Missouri's GDP to evolve over time. More concretely, the *Ak* model replicates the fact that the Missouri economy, on average, grows over time. I used this feature of the model economy to compute the evolution of the Missouri economy over time, with and without production at the Noranda Smelter.

Q: Is there another way of describing your computation?

A: Yes. I have used the economic model described above to quantify the impact of Noranda's Smelter on the Missouri economy. This impact is computed by considering the following thought experiment. The baseline path involves the path for the Missouri economy over time *with* the Noranda Smelter, and all other human and physical capital employed in Missouri. This baseline serves as the control for the experiment. For 2014, I assume a 20 percent reduction of the smelter's employment and production occurs. Then, **_____** the smelter is subject to completely shutting down. If Noranda's New Madrid Smelter shuts down, I assume that those resources are not immediately re-employed in the Missouri economy. By shutting down the smelter, there is a new path for Missouri's GDP. Over time, through economic growth, those resources will be absorbed and used in some productive capacity, but it is as if the Missouri economy starts from a lower value of GDP and then grows. I then compare the path for Missouri's GDP with the Noranda smelter operating and with the Noranda smelter shut down. I conduct this analysis for a period of twenty-five years, the length of a generation. I also compute the economic impact over a ten-year span beginning in 2014. Over whatever span

of time I examine, the difference between the two paths is the measure of the economic impact of the Noranda smelter.

To draw on a medical analogy, consider two patients who have the same diseases. The control patient is treated with a placebo while the other patient is treated with an experimental drug. The effect of the drug is measured by the difference between the health outcomes of the control patient and the health outcome of the patient treated with the experimental drug. For the purposes of measuring the economic impact, hold everything else constant in the Missouri economy, close the Noranda smelter, and compare the two outcomes. Closing the Noranda smelter is essentially the treatment on the Missouri economy and I measure the effect of the treatment.

State GDP

Q: **Please describe the specific steps included in your computation of the economic impact of the Noranda smelter in Missouri.**

A: As noted above, I looked at this question by comparing the expected path of Missouri's economy with the smelter and the expected path of Missouri's economy with smelter shutdown. The first step is to determine the baseline, which is a forecast of the path of Missouri's Gross Domestic Products (GDP) for a twenty-five year period assuming the Noranda smelter continues to operate. The second step is to compute the path of Missouri's GDP with the shutdown, thus taking the value

of the production at the Noranda smelter out of Missouri's economy and starting a new path.

Q: How did you compute the baseline path—the expected path of Missouri's economy with the Noranda smelter?

A: The baseline path is constructed using the average annual growth rate in Missouri's real GDP between 1997 and 2012. I focused on real GDP in order to avoid having to forecast future movements in the inflation rate. The average annual growth rate for Missouri's GDP is 1.03 percent. The Bureau of Economic Analysis reports that Missouri's 2012 real GDP was $221.702 billion. Here, real GDP is measured as state GDP using a chain-weighted index in which the base period is 2005. For each year between 2012 and 2037, I forecasted Missouri's GDP by following the equation: $Y_t = 1.010344 * Y_{t-1}$, where Y is state real GDP. I initialized this forecast with Missouri's 2012 GDP, that is, Y_{2012} = $221.702 billion.

Q: What is the expected growth in Missouri GDP over twenty-five years with the Noranda smelter?

A: Using this formula, it is my conclusion that the Missouri GDP will grow from $221.702 billion in 2012 to $245.732 billion in 2022 and to $286.749 billion in 2037 with the Noranda smelter operations.

Q: How did you compute the alternate path—the expected path of Missouri's economy without the Noranda smelter?

A: I constructed the alternate path by assuming that the value of aluminum production at the Noranda smelter as zero **_____** because the smelter is shut down. In other words, the economic value goes to zero for that smelter's contribution to Missouri's GDP in **_____**. The Missouri economy, therefore, starts from a lower GDP base **_____** and it takes time for those resources to be re-employed. As with the baseline path, I used values taken from 2012 to initialize the economic impacts. Noranda reports that the value of aluminum production at the New Madrid Smelter is $626.371 million. Following the *Ak* growth model, I computed the effect that the decline in production would have on the Missouri economy. Here, the value of A is calibrated to hit the average annual growth rate of the Missouri economy; that is, $A = 0.863236$. The total change in the production is minus $626.371 million. By subtracting the production from the initial value of Missouri real GDP, the treated value of Missouri's real GDP in 2012 is $221.085 billion. I estimated the impact of the lost production on the final goods and services produced in Missouri. In this case, with the loss of $626.371 million in 2012 and for a period of either ten or 25 years, Missouri's GDP would decline by 20 percent of $626.371 million between **_____** compared to its baseline, or control, level. This means that without the productive capacity of Noranda's smelter, Missouri's 2014 real GDP would be $226.187 billion rather than $226.312 billion. The remaining 80 percent of production stops **_____**. Because the lost production does not affect the return to the remaining human and physical capital,

the *Ak* model economy does not recognize any decline in the state economy's growth rate. Thus, I followed the same method to construct the path for Missouri's GDP for the next twenty-five years; that is, T+10 and *T+25,* without production at the Noranda smelter. By following this method, I computed the revised Missouri GDP, Y^*_{T+10} = $245.063 and Y^*_{T+25} = $285.967 billion where Y^* denotes the revised level of Missouri GDP without the Noranda physical capital. With sequence of values of Missouri GDP, the economic impact of the Noranda smelter over the next ten or twenty-five years is the discounted sum of the differences between projected Missouri GDP with Noranda's physical capital and the projection in which Noranda's physical capital is omitted. This is expressed by the following equation:

$$\sum_{t=T}^{T+25} \rho^{t-T}(Y_t - Y_t^*)$$

where ρ is the discount factor, or the rate at which one discounts the future levels of Missouri GDP. Here, I use ρ = 0.96.

Q: What is your conclusion concerning the expected growth in Missouri GDP over twenty-five years without the Noranda smelter?

A: Using this formula, it is my conclusion that the discounted sum of Missouri's foregone GDP associated with Noranda's lost production is $8.917 billion over the next twenty-five years. In other words, without the Noranda smelter, Missouri's GDP will be $8.917 billion less than it would be with the Noranda smelter over this twenty-five year period. If I compute the economic impact over the next ten years, the discounted value is $3.646 billion.

State and Local Tax Revenues

Q: How did you determine the impact of the closing of Noranda's smelter on state tax revenues?

A: Once the economic impact in terms of foregone state GDP is computed, it is straightforward to compute the impact on Missouri's tax revenue. I looked at "net general revenue" for the state which includes Missouri individual income taxes, Missouri corporate income taxes, Missouri franchise taxes and other taxes paid to the state general revenue fund (including some Missouri sales and use taxes). Here, net refers to amounts collected after refunds. On average, Missouri's net general revenue fund receives 3.8 cents per dollar of amount of state GDP. I multiplied 0.038 times the change in amount of state GDP to compute the expected loss to state net general revenues over the next ten or twenty-five years that would result from the closing of Noranda's smelter.

Q: What is your conclusion concerning the effect of the closing of the Noranda smelter on state net general tax revenues over the next twenty-five years?

A: My calculations indicate that Missouri state government would forego the collection of $338.87 million over the next twenty-five years if the Noranda smelter is subject to closure. That is, the discounted sum of state general revenue funds would be reduced by $338.87 million. Over the next ten years, the discounted sum of state general revenue funds would be reduced by $138.55 million.

Q: What other tax collections would be affected by the closure of the Noranda smelter?

A: Noranda pays other state and local taxes as a result of the operation of the smelter. I have calculated the impact of Noranda's smelter closing on personal property tax, real estate tax, and unemployment insurance tax.

Q: How did you determine the impact of the closing of Noranda's smelter on local property tax collections?

A: Noranda reports that in 2013, it paid $3.724 million in property taxes on tangible personal property and real estate. This $3.724 million is owed on the value of land, machines and equipment held by Noranda in 2012. When the Noranda smelter is subject to shutting down **_____**, I assume the property tax base will shrink. One scenario,for example, is that the property tax on unused land goes to zero. In this scenario, I assumed that the tax bill would have grown at the same rate as the Missouri state GDP; that is, 1.03 percent. I applied this growth rate in the property tax bill for the period **_____**. I discounted the future tax liabilities at the same rate as I did in the case of the foregone state GDP.

A more likely scenario is that with the shrinking property tax base, the local government tax burden will be shifted to those households and businesses that remain in the taxing jurisdiction. The harm, therefore, will not be borne by the local government, but the tax bill will shifted onto those properties in the tax jurisdiction. By raising their property tax bills, the people and businesses would realize a reduction in their disposable income and a reduction in their personal

expenditures; in other words, the residents and businesses would not be able to spend as much on cars, foods, and new equipment, for instance.

Q: What is your conclusion concerning the effect of the closing of the Noranda smelter on personal property tax collections over the next twenty-five years?

A: It is my conclusion that the discounted sum of future personal property taxes that would not be paid by Noranda if the smelter were subject to closure; the value of the foregone property taxes is equal to $51.45 million over the next twenty-five years if the lost revenue from Noranda is not made up by increased collections on remaining taxpayers. Over the next ten years, the discounted sum of future personal property taxes foregone would be $20.24 million if the lost revenue from Noranda is not made up by increased collections on remaining taxpayers. Alternatively, if the remaining residents and businesses would suffer higher property tax bills, these dollar amounts represent foregone personal expenditures or savings that these people would have in their disposable income in the case that the Noranda Smelter did not close.

Q: How would you summarize the effect of closing Noranda's New Madrid Smelter on state and local tax collections?

A: The upshot is that if the Noranda New Madrid Smelter were closed, there would be costs in the form of foregone state GDP. Because the Missouri economy would shrink, there would be fewer taxes collected by both state and local governments. I estimate that the lost state and local revenues would be $390.33 million over a

generation. Over a ten-year period, the loss is $158.79 million. Schedule 1 summarizes the cost to the state and local governments in the form of lost tax receipts.

Schedule 1 computes the loss to local property taxes based on the view that the local government bears the burden of the reduction in the local tax base resulting from the closure of the Noranda Smelter. If the remaining citizens bear the cost by paying higher local property taxes, the loss is a combination of foregone state net general revenue and personal expenditure.

Unemployment Insurance

Q: What data did you rely on in determining the impact of the closing of Noranda's smelter on Missouri unemployment insurance benefit payments?

A: If the Noranda smelter were to close, there would be additional costs to Missouri state government in the form of unemployment insurance claims made by workers separated from work. The average unemployment duration is 9.5 weeks. Note that 9.5 weeks is the unconditional average number of weeks that a person is unemployed. In other words, the average duration is not conditional on the current state of the aggregate United States' economy. According to data published by the Bureau of Labor Statistics, the average duration of an unemployment spell is 36.1 weeks in October 2013. The median duration is 16.3 weeks. These data are published at: http://www.bls.gov/news.release/empsit.t12.htm. Missouri's unemployment benefits are computed based on the worker's quarterly wages.

Specifically, a worker's weekly benefit amount (WBA) will be 4 percent of the average of the worker's two highest quarters, but cannot be more than $320.

Q: What other facts did you rely on in determining the impact of the closing of Noranda's smelter on Missouri unemployment insurance benefit payments?

A: While I do not have data on the individual workers' salaries at Noranda, officials tell me that the average total wage for hourly Noranda employees is $60,000. Their average quarterly wage is $15,000. Weekly unemployment benefits in Missouri are calculated as 4 percent of average quarterly salary or $320, whichever is smallest.

Q: How did you determine the impact of the closing of Noranda's smelter on Missouri unemployment insurance benefit payments to Noranda's employees?

A: Since 0.04 times $15,000 is $600, I assumed that each of the 888 employees at the Noranda smelter in New Madrid, Missouri would receive weekly benefits equal to $320. I then applied the median number of weeks of benefits, and found that expected weekly unemployment insurance benefits paid to these workers would be $4,631,808 **_____**. If I used the sample mean duration instead of the median duration, the expected unemployment insurance benefits would be $10,258,176, **_____**.

Summary

Q: How would you summarize your conclusions concerning the impact of the closing of Noranda's smelter on the Missouri economy?

A: I have applied standard economic theory to compute the effect that eliminating Noranda's New Madrid Smelter would have on the Missouri economy. I treated the case in which the physical capital employed by Noranda vanishes. For the twenty-five year period after the smelter stops operating vanishes, the discounted sum of lost state GDP is $8.917 billion. Over a ten-year period, the discounted sum of lost state GDP is $3.646 billion. In addition, state and local government revenues are not paid. The discounted sum of lost net general revenue paid to the state is $338.87 million over the twenty-five year period. ** _____ ** the discounted sum of lost net general revenue is $138.55 million. Personal property taxes plus real estate taxes would also be reduced by $51.45 million over the period 2014-2039 if the lost revenue from Noranda is not made up by increased collections on remaining taxpayers. If we focus on the period 2014 through 2024, the discounted sum of personal property taxes would decline by $20.24 million without Noranda operating if the lost revenue from Noranda is not made up by increased collections on remaining taxpayers. Or, the reduction in the local property tax base would be shifted to remaining residents and businesses, resulting in a reduction in disposable income and, therefore, a reduction in personal expenditures. Finally, the state would incur costs as a result of the payment of unemployment insurance benefits. If the smelter shutdown occurred, on average, the state would expect to pay nearly $4.4 million in unemployment

insurance benefits. If, however, the smelter shutdown occurred and the average duration of the unemployment spell was completely covered, the state would expect to pay over $9.8 million in unemployment insurance benefits. Schedule 1 summarizes the cost to the state and local governments in the form of lost tax receipts.

Schedule 1

Tax Category	Present value summed over 25 year period	Present value summed over 10 year period
Net General Revenue foregone	$338.87 million	$138.55 million
Local Property Tax (not collected)	$51.45 million	$20.24 million

Schedule 2 summarizes the total unemployment insurance bill for both hourly and salaried Missouri residents for each of the three alternative expected-duration assumptions.

Schedule 2

Employee category	Unconditional Mean unemployment duration = 9.5 weeks	Median unemployment duration = 16.3 weeks	Cyclically-adjusted Mean unemployment duration = 36.1 weeks
1st round (2014)	$608,000	$1,043,200	$2,310,400
2nd round **(_____)**	$2,091,520	$3,588,608	$7,947,776

Q: Does this conclude your testimony?

A: Yes.

January 2014

CURRICULUM VITA

JOSEPH H. HASLAG

ADDRESS: Department of Economics
University of Missouri-Columbia
Columbia, MO 65211

PERSONAL DATA: Date of Birth: March 28, 1961
Marital Status: Married (Sara)
Citizenship: United States

EDUCATION: Ph.D., Economics, Southern Methodist University, Dallas, TX, 1987.
M.A., Economics, University of Missouri-Columbia, Columbia, MO, 1984.
B.S., University of Missouri-Columbia, Columbia, MO, 1982.

AWARDS

Who's Who in America, 2008-Present

AREAS OF SPECIALIZATION:

Monetary Theory
Growth and Development
Financial Institutions
Macroeconomic Theory

PROFESSIONAL EXPERIENCE:

Professor, Department of Economics, University of Missouri, February 2008 - Present
Professor of Economics, Department of Economics, University of Missouri-Columbia, September 2006-January 2008
Associate Professor of Economics, Department of Economics, University of Missouri-Columbia, 2000-2006
Executive Director, Economic Planning and Research Center, University of Missouri--Columbia, June 2002 – Present
Visiting Scholar, Federal Reserve Bank of Kansas City, 2001-03.
Visiting Scholar, Federal Reserve Bank of Atlanta, Fall 2000.
Visiting Scholar, Federal Reserve Bank of Cleveland, Fall 2008.
Visiting Scholar, Federal Reserve Bank of St. Louis, Fall 2010.
Visiting Professor of Economics, Michigan State University, Spring 2000.
Senior Economist and Policy Advisor, Research Department, Federal Reserve Bank of Dallas, December 1995 to August 2000.

Visiting Professor of Economics, Southern Methodist University, January 1989, to December 1998.
Visiting Scholar, Erasmus University, Rotterdam, The Netherlands, June 1991.
Senior Economist, Research Department, Federal Reserve Bank of Dallas, September 1990 to November 1995.
Economist, Research Department, Federal Reserve Bank of Dallas, January 1988 to August 1990.
Economist, Research and Public Affairs Department, Federal Reserve Bank of St. Louis, July 1987 to January 1988.
Adjunct Assistant Professor of Finance, University of Missouri-St. Louis, September 1987 to January 1988.
Instructor, Department of Economics, Southern Methodist University, August 1986 to May 1987.
Instructor, Department of Economics, University of Texas-Arlington, August 1986 to May 1987.

PUBLISHED PAPERS:

1) "Government Policy under Price Uncertainty: A Source of Volatility in Illegal Immigration" (joint with Mark Guzman and Pia Orrenius), *Canadian Journal of Economics*, forthcoming

2) "Unconventional Optimal Open Market Purchases," (joint with Chao Gu), *Review of Economic Dynamics*, forthcoming

3) "Production, hidden action, and the payment system," (joint with Chao Gu and Mark Guzman), *Journal of Monetary Economics*, March 2011, 58(2), 172-182.

4) "Why does overnight liquidity cost more than intraday liquidity," (joint with Joydeep Bhattacharya and Antoine Martin), *Journal of Economic Dynamics and Control*, June 2009, 33(6), 1236-46.

5) "Optimal monetary policy and economic growth," (joint with Joydeep Bhattacharya and Antoine Martin, *European Economic Review*, February 2009, 53(2), 210-21.

6) "Who is afraid of the Friedman Rule?" (joint with Joydeep Bhattacharya, Antoine Martin and Rajesh Singh), *Economic Inquiry*, April 2008, 46(2), 113-30.

7) "Understanding the cost difference between intraday and overnight liquidity," *Journal of Financial Transformation,* 2008, 24, 105-07.

8) "On the determinants of optimal border enforcement," (joint with Mark Guzman and Pia Orrenius), *Economic Theory*, February 2008, 34(2), 261-96.

9) "Optimality of the Friedman Rule in an overlapping generations model with spatial separation," *Journal of Money, Credit, and Banking,* October 2007, 39(7), 1741-1758.

10) "On Money and Output: Is Money Redundant?" (joint with Rik Hafer and Garret Jones), *Journal of Monetary Economics*, April 2007, 54(3), 945-54.

11) "Suboptimality of the Friedman Rule in Townsend's turnpike and Stochastic Relocation Models of Money: Do Finite Lives and Initial Dates Matter?" (joint with Joydeep Bhattacharya and Antoine Martin), *Journal of Economic Dynamics and Control*, May 2006, 30(5), 879-97.

12) "Heterogeneity, Redistribution and the Friedman Rule," (joint with Joydeep Bhattacharya and Antoine Martin), *International Economic Review*, May 2005, pp. 437-454.

13) "The Role Of Money in Two Alternative Models: When is the Friedman Rule Optimal, and Why?" (joint with Joydeep Bhattacharya and Steven Russell), *Journal of Monetary Economics*, November, 2005.

14) "The Non-Monotonic Relationship between Seigniorage and Inequality," (joint with Joydeep Bhattacharya and Helle Bunzel), *Canadian Journal of Economics*, May 2005, 500-19.

15) "Crony Capitalism and Financial System Stability" (joint with Rowena Pecchenino), *Economic Inquiry*, January 2005, pp. 24-38.

16) "Is Reserve Requirement Arithmetic More Pleasant?" (with Joydeep Bhattacharya), *Economica*, August 2003, pp. 271-91.

17) "Monetary Policy, Fiscal Policy, and the Inflation Tax: Equivalence Results," (with J. Bhattacharya and S. Russell), *Macroeconomic Dynamics*, 7, October 2003, pp. 647-69.

18) "On the Use of the Inflation Tax when Non-Distortionary Taxes are Available," (with Joydeep Bhattacharya) *Review of Economic Dynamics*, 4(4), October 2001, pp. 823-41.

19) "Reliance, Composition, and Inflation," *Economic & Financial Review*, Federal Reserve Bank of Dallas, First Quarter 2001, pp. 20-28.

20) "Monetary Policy Arithmetic: Some Recent Contributions," *Economic & Financial Review*, Federal Reserve Bank of Dallas, (with Joydeep Bhattacharya), Third Quarter 1999, pp. 26-36, [cited in "Recommendations for Further Reading, *Journal Of Economic Perspectives* 14(2), Spring 2000].

21) "Money Creation, Reserve Requirements, and Seigniorage," (with Eric Young) *Review of Economic Dynamics*, Issue 3, 1998, pp. 677-98.

22) "Seigniorage Revenue and Monetary Policy: Some Preliminary Evidence," *Economic Review*, Federal Reserve Bank of Dallas, 3rd Quarter 1998, pp. 10-20.

23) "Monetary Policy, Banking, and Growth," *Economic Inquiry*, 36(3), 1998, pp. 489-500.

24) "Output, Growth, Welfare, and Inflation: A Survey," *Economic Review*, Federal Reserve Bank of Dallas, 2nd Quarter, 1997, pp. 11-21, [cited in "Recommendations for Further Reading, *Journal of Economic Perspectives*, 1998].

25) "On the Optimality of Interest-Bearing Reserves in Economies of Overlapping Generations," (with Scott Freeman) *Economic Theory*, 7, 1996, pp. 557-65.

26) "Implementing Monetary Base Rules: The Currency Problem," (with R.W. Hafer and Scott Hein) *Journal of Economics and Business*, 1996, pp. 461-72.

27) "Should Bank Reserves Pay Interest?" (with Scott Freeman), *Economic Review*, Federal Reserve Bank of Dallas, Fourth Quarter, 1995, pp. 25-33.

28) "Measuring the Policy Effects of Changes in Reserve Requirements," (with Scott E. Hein), *Economic Review*, Federal Reserve Bank of Dallas, Third Quarter, 1995, pp. 2-15.

29) "Does It Matter How Monetary Policy Is Implemented?" (with Scott Hein), *Journal of Monetary Economics*, 35(May) 1995, pp. 359-86.

30) "Quasi-Balance Sheet Measures of U.S. Monetary Policy: A Closer Look," (with Scott E. Hein) *Journal of Money, Credit, and Banking*, February 1995, pp. 124-39.

31) "Cyclical Fluctuations, Macroeconomic Policy and the Size Distribution of Income: Some Preliminary Evidence," (with D. J. Slottje) *Journal of Income Distribution*, Spring 1995 pp. 3-23.

32) "Monetary Policy and Recent Business-Cycle Experience," (with R.W. Hafer and Scott E. Hein), *Economic Review*, Federal Reserve Bank of Dallas, Third Quarter 1994, pp. 14-28.

33) "Are Net Discount Ratios Stationary: Some Further Evidence," (with Michael Nieswiadomy and D. J. Slottje) *Journal of Risk and Insurance*, 61(3), 1994, pp. 513-18.

34) "A Longer Look at Developments in the Distribution of Income," (with Lori L. Taylor), *Economic Review*, Federal Reserve Bank of Dallas, First Quarter 1993, pp. 19-30.

35) "Macroeconomic Activity and Monetary Policy Actions: Some Preliminary Evidence," (with Scott E. Hein) *Journal of Money, Credit, and Banking*, November 1992, pp. 431-46.

36) "A Theory of Fed Watching in a Macroeconomic Policy Game," (with Nathan S. Balke) *International Economic Review*, August 1992, pp. 619-28.

37) "Are Net Discount Rate Stationary?: The Implications for Present Value Calculations," (with Michael Nieswiadomy and S. J. Slottje) *Journal of Risk and Insurance*, September 1991, pp. 507-12.

38) "Variability and Forecastability of Central Bank Preferences in a Monetary Policy Game," (with Nathan S. Balke) *Journal of Macroeconomics*, Summer 1991, pp. 535-41.

39) "Money Growth, Supply Shocks, and Inflation," (with D'Ann M. Ozment) *Economic Review*, Federal Reserve Bank of Dallas, May 1991, pp. 1-17.

40) "Economic Activity and Two Monetary Base Measures," (with Scott E. Hein) *Review of Economics and Statistics*, November 1990, pp. 672-76.

41) "Monetary Aggregates and the Rate of Inflation," *Economic Review*, Federal Reserve Bank of Dallas, March 1990, pp. 1-12.

42) "Federal Reserve System Reserve Requirements: 1959-88," (with Scott E. Hein) *Journal of Money, Credit, and Banking*, November 1989, pp. 515-23.

43) "Reserve Requirements, the Monetary Base and Economic Activity," (with Scott E. Hein), *Economic Review*, Federal Reserve Bank of Dallas, March 1989, pp. 1-15, [reprinted in Readings to accompany The Economics of Money, Banking, and Financial Markets, James W. Eaton and Frederic S. Mishkin, ed. and Readings on Financial Institutions and Markets, Donald R. Fraser and Peter S. Rose, ed.]

44) "A Study of the Relationship Between Economic Growth and Inequality: The Case of Mexico," (with Thomas B. Fomby and D. J. Slottje), *Economic Review*, Federal Reserve Bank of Dallas, May 1988, pp. 13-25.

45) "The FOMC in 1987: The Effects of a Falling Dollar and the Stock Market Crash," (with R. W. Hafer), *Review*, Federal Reserve Bank of St. Louis, March/April 1988, pp. 3-16.

46) "The Market Value of Government of Canada Debt, Monthly, 1937-84," (with W. Michael Cox) *Canadian Journal of Economics*, August 1986, pp. 469-97.

47) "A Sensitivity Analysis of the Effect of Fiscal and Monetary Policy on the Size Distribution in the U.S.," (with William R. Russell and S. J. Slottje) *Advances in Econometrics*, George F. Rhodes, ed., 1986, pp. 97-142.

CURRENT WORK:

"Money and Coordination Failure: a New Look" (joint with Jim Dolmas)

"The Cyclical Behavior of the Price Level and Inflation: A Probabilistic Approach (joint with William A. Brock)

SHORT ARTICLES:

"Grading Tips: An I for Incomplete," *The Southwest Economy*, Issue 5, 1998.

"Honest Money is the Best Policy," *The Southwest Economy*, Issue 3, 1996 (reprinted in the Durell Journal of Money and Banking).

"U.S. Economic Forecast Calls for Slightly Slower Growth," *The Southwest Economy*, Issue 5, 1994.

"The U.S. Economy: A Brighter Outlook after a Bumpy Ride," (with Harvey Rosenblum) *The Southwest Economy*, March/April 1993.

"The Haves and the Haves-Nots: A Study of Income Inequality," (with Lori L. Taylor and Kelly Whealan) *The Southwest Economy*, September 1992.

"Trends in Income Mobility," (with Lori L.Taylor and Kelly Whealan) *The Southwest Economy*, September 1992.

BOOKS:

Modelling Monetary Economies, 3rd ed. Cambridge, U.K.: Cambridge University Press, 2011 (with Bruce A. Champ and Scott Freeman).
Macroeconomic Activity and Income Inequality in the United States, Greenwich, CT: JAI Press, 1989 (with W.R. Russell and D.J. Slottje).

REPORTS:

"What makes a good tax structure," joint with Haleigh Albers (Show-Me Institute Essay)
"Slip Sliding Away: The Weak Relative Growth of the Missouri Economy" joint with Mikchael Podgursky (Show-Me Institute essay)
"Income taxes vs. Sales taxes: A welfare comparison" joint with Grant Casteel (Show-Me Institute Essay)
"Unleashing video competition: The benefits of cable franchise reform to Missouri consumers," Show-Me Institute No. 8, February, 2007.
"How to replace the earnings tax in Kansas City," Show-Me Institute No.6 , January 2007.
"How to replace the earnings tax in St. Louis," Show-Me Institute No.5 , January 2007.
"How an earnings tax harms cities like St. Louis and Kansas City" Show-Me Institute No.1, April 2006.
"The Economic Impact of the School of Health Professions at the University of Missouri-Columbia"
"The Economic Impact of the New Basketball Arena at the University of Missouri-Columbia"
"Toward the Identification of Adult Training Program Opportunities" (with D. W. Stevens and R. L McHugh).
"Using Available Data to Target Re-Training Allocations in Missouri" (with D. W. Stevens).

GRANTS:

Missouri Technology Corporation, $25,000, Spring 2005.
International Travel Grant, University of Missouri-Columbia, $1500, Summer 2001.

STUDENTS:

Martin Peyera—chair dissertation (2008)
Ok-Sun Seo—chair dissertation (2006)
Jaepil Park—chair dissertation (2004)
Varavuth Chintarajeda—chair dissertation (2004)
Chao Gu—chair master's thesis (2002)
Dean Crader—chair master's thesis (2003)
Brian Banner—chair master's thesis (2004)

PAPERS PRESENTED (last five years):

"Unconventional optimal open market purchases," Federal Reserve Bank of Chicago Money Workshop (August 2012), Missouri Economics Conference (March 2012), University of Kansas (September 2013)
"Money and Coordination Failure: A New Look," University of Alabama (October 2013)
"Production, hidden action, and the payment system," Midwest Macro meetings (May 2008), Texas A&M (Oct. 2008), SMU (Oct 2008), Federal Reserve Bank of Dallas (Oct 2008), Federal Reserve Bank of Cleveland (Nov. 2009), Federal Reserve Bank of St. Louis (Dec 2010).

PROFESSIONAL MEMBERSHIPS:

American Economic Association
Econometric Society
Society of Economics Dynamics

REFEREE FOR:

American Economic Review, Journal of Monetary Economics, International Economic Review, Review of Economic Dynamics, Review of Economics and Statistics, European Economic Review, Economic Theory, Economic Inquiry, Journal of Money, Credit, and Banking, Review of International Economics, Southern Economic Journal, Journal of Macroeconomics, Journal of Economic Behavior and Organization, Journal of Income Distribution

Associate Editor, *Economic Inquiry* from 2003-2008.

COURSES TAUGHT:

Macroeconomic Theory (Core Graduate, both semesters)
Monetary Theory (Graduate)
Monetary Theory and Policy (advanced undergraduate)
Macroeconomic Theory and Policy (advanced undergraduate level)
Intermediate Microeconomics

Intermediate Macroeconomics
Money and Banking
Principles (Micro and Macro)
(evaluations available upon request)

DEPARTMENT & UNIVERSITY SERVICE:

Organized Missouri Economics Conference in 2001, 2004, 2006, 2010, 2011, 2012;local coordinator in 2001-2012.
Organized Texas Monetary Conference in 1994 and 1999.
University of Missouri System Benefits Committee, 2004-2011
University of Missouri Academic Grievance Committee, member 2003-
Lectureship in American Traditions and Values Committee, member 2003-2004
Member, Provost Committee for Economic Development, Human Resources and Public Policy Committees, 2006-2010.

OPINION ARTICLES:

--published numerous opinion articles in the Kansas City Star, St. Louis Post Dispatch, St. Louis Beacon, Springfield News Leader, and Columbia Tribune.

--resident economics commentator for Columbia Business Times, 2010-2012

REFERENCES:

References available upon request

The Impact of

The Noranda Smelter on Missouri's Economy

A report by

Joseph H. Haslag

Professor of Economics

University of Missouri

January 24, 2014

I. Introduction

According to the testimony of Noranda's CEO Kip Smith:

"Noranda is an integrated aluminum manufacturer. It is an energy-intensive and capital-intensive commodity business."

"In addition to its smelter near New Madrid, Missouri, Noranda owns and operates a bauxite mine in Jamaica and an alumina refinery in Gramercy, Louisiana. The New Madrid Smelter produces molten aluminum and converts molten aluminum to aluminum products such as billet, rod, foundry products and primary ingots. The smelter has been operating in southeast Missouri since February 25, 1971. Its primary product inputs are electricity and alumina. The alumina is delivered via barge over the Mississippi River. Alumina, also known as aluminum oxide, is produced from bauxite ore. The New Madrid Smelter processes the alumina through three production lines that electrolytically convert aluminum oxide into molten aluminum. The process requires an unusually large amount of electricity. On an annual basis, the New Madrid Smelter purchases about the same amount of electricity as the entire city of Springfield, MO. Electricity must also be constantly available to the production lines, otherwise the lines will be damaged from liquid metal solidifying in the lines. When at full production, the smelter produces more than 260,000 metric tons of aluminum per year. The aluminum is sold primarily in North America. Noranda is one of the largest foil producers in North America and a major producer of light gauge sheet products."

Noranda Aluminum, Inc. is a leading North American integrated producer of value-added primary aluminum products. Noranda is a publicly traded company on the New York Stock Exchange. The company was founded in 1968 and operates an aluminum smelting facility at St. Jude Industrial Park near New Madrid, Missouri. At their request, I have computed the economic impact that Noranda Aluminum's New Madrid Smelter has on the Missouri economy. Specifically, I have quantified the impact in terms of the effect on the value of final goods and services produced within Missouri's borders each year; that is, Missouri's state Gross Domestic Product. In addition, I have computed the effect on state and local government tax collections.

For the sake of disclosure, Noranda has supplied data on production and taxes paid at the New Madrid facility. In addition, Noranda supplied price data for aluminum. Armed with the price and production data, it is straightforward to compute the value of goods and services produced at the New Madrid Smelter. In this report, I accept those data as factual. The economic modeling and the calculations are solely my responsibility.

Three main economic issues regarding the impact of the closing of the New Madrid Smelter will be presented in this report:

1. GDP Loss

   Over a generation, the impact that the New Madrid facility has on the Missouri economy is, after discounting, computed to be $8,917 million. In other words, Missouri's economy would forego nearly $9 billion in economic activity if the Noranda facility were closed. Over a ten-year period, the expected value of state GDP loss would be $3.646 billion.

2. State and Local Taxes

   State and local tax collections would be affected. At the state level, net general revenue funds over the next twenty-five years, after discounting, would be $338.87 million lower if the Noranda Smelter closed permanently compared with an economic projection in which the Noranda physical capital is fully utilized. Over the ten-year period, the present value of lost net general revenue funds is $138.55 million. In addition, local taxes will be affected. By closing the Noranda Smelter, the local property tax base would shrink. By my estimates, the present value of the local property receipts would be reduced by $51.45 million if the lost revenue from Noranda is not made up by increased collections on remaining taxpayers. Over the next ten years, the value of the local property receipts would be reduced by $20.24 million, provided the lost taxes paid by Noranda are not made up by increased collections from remaining taxpayers. When the tax base shrinks, the tax

burden is frequently reallocated to remaining taxpayers. So, property taxes burdens are redistributed to citizens, thereby harming them by reducing their personal expenditures.

3. Unemployment Insurance Benefits

Were the Noranda Smelter to shut down, layoffs would result. There are 888 employees at the New Madrid Smelter that would lose their jobs **_____** were the smelter to close. The expected value of unemployment insurance benefits paid by Missouri between **_____** is equal to $2.7 million. In the current economic environment, however, the expected length of an unemployment spell is 36.1 weeks. With benefits paid for the entire spell, the expected unemployment insurance benefits would equal $10.3 million owing to closing the Noranda Smelter.

Overall, the New Madrid smelting facility operated by Noranda has large economic impacts compared to the typical business operation. It employees a large number of people and has a large capital stock utilized to smelt aluminum. The calculations are based on the assumption that were Noranda to shut down the New Madrid, MO facility, then the productive inputs—namely, the people, machines, and other equipment—would be freed up by the shutdown and not be immediately employed in Missouri. Over time, these resources could be employed in Missouri as the state economy grows. The immediate effect reduces the amount of productive resources.

II. Economic Model

Economic theory provides the basis for my calculations. I follow the *Ak* growth model developed by Rebelo (1991) and implemented by Ireland (1996) to compute the effect that the reduction in the factor inputs—people, machines and equipment—would have on the Missouri economy. The basic idea is that physical capital and human capital are combined to produce goods and services. The value of those goods and services is what is known as Gross Domestic Product (GDP).

To make this more concrete, suppose that the Missouri economy was measured by valuing all the final goods and services produced within the state's boundaries. The value of this production is called Gross Domestic Product at the state level.

In the case of Noranda's New Madrid smelting facility, it is producing aluminum that is sold to buyers. The buyers are using that aluminum to produce other goods and services. To measure the impact that the Noranda Smelter has on the Missouri economy, we can compute the value of the production undertaken by Noranda. The value of the production represents resources used to pay workers, rental payments on the machines and equipment, interest payments to lenders, and returns to Noranda's owners. This approach follows the factor cost approach to measuring GDP.

Formally, the production of final goods and services produced within Missouri's boundaries is represented by the function

$$Y_t = Ak_t \qquad (1)$$

where Y stands for Missouri's GDP for a year indexed by t, k the quantity of human and physical capital employed at date t, and A is the technology that represents the rate at which human and physical capital are transformed into units of final goods and services.

This equation serves as the basis for computing the effect that Noranda's New Madrid Smelter has on the Missouri economy. Here, there is a market value of the facility physical capital. I treat the human capital input as being retained in Missouri while the physical capital input vanishes for the case in which the smelter is shut down. Put another way, k changes as the operation of the Noranda Smelter changes. With A, it is straightforward to compute the change in Missouri's GDP, Y, that corresponds to a change in k employed within Missouri's boundaries.

The changes impact the Missouri economy over time. This model explicitly deals with changes occurring over time. You can see this explicitly in equation (1) by the fact that output and the capital input both have time subscripts. Equation (1) represents the relationship between output and the capital input at a particular date. In other words, output is measured *at a point in time*, which is typically a year. As the time

subscripts changes, the model economy is capturing how the Missouri's GDP evolves over time. For example, the *Ak* model allows for the Missouri economy, on average, growth over time. With this growth feature in the model economy, I can conduct the following experiment; specifically, I can compute the evolution of the Missouri economy over time, with and without production at Noranda's New Madrid smelting facility.

The purpose of this section is to familiarize the reader with the basic properties of the economic model used to quantify the impact that the Noranda Smelter has on the Missouri economy. The economic impact is computed by considering the following thought experiment. The baseline path involves the path for the Missouri economy over time with the Noranda Smelter, and all the other human and physical capital employed in Missouri. This baseline serves as the control for the experiment. If Noranda's New Madrid Smelter were subject to shutting down **_____**, the resources employed at this facility are freed up. Over time, these resources can be utilized as part of the economy's growth. By shutting down the smelter, there is a new path for Missouri's GDP. I then compare the path for Missouri's GDP with and without the Noranda Smelter operating. I conduct this analysis for a period of twenty-five years, the length of a generation. In addition, I compute the discounted sum of lost state GDP over a ten-year period. The difference between the two paths is a measure of the economic impact of the Noranda smelter.

To draw on a medical analogy, consider two patients who have the same disease. The control patient is treated with a placebo while the other patient is treated with an experimental drug. The effect of the drug is measured by the difference between the health outcome of the control patient and the health outcome of the patient treated with the experimental drug. For the purposes of measuring the economic impact, hold everything else constant in the Missouri economy, close the Noranda Smelter, and compare the two outcomes. Closing the Noranda Smelter is essentially the treatment on the Missouri economy and I measure the effect of the treatment.

III. Measuring the Economic Impact

The purpose of this report is to compute the economic impact of the Noranda Smelter in Missouri. More specifically, the question is, what would Missouri's economy look like with and without the existence

of the smelter? I look at the question by comparing the expected path of Missouri economy with the smelter. The first step, or the baseline, is a forecast of the path of Missouri's Gross Domestic Product (GDP) for a twenty-five year period, assuming the Noranda Smelter continues to operate. The second step is to compute the path of Missouri's GDP taking the capital of the Noranda Smelter out of the equation.

The baseline path is constructed using the average annual growth rate in Missouri's real GDP between 1997 and 2012. I focus on real GDP in order to avoid having to forecast future movements in the inflation rate. Table 1 reports the values of real GDP in each year.

Table 1 (mils of 2005 chained $)

Year	1997	2012
Real GDP	$189,990	$221,702

Source: Bureau of Economic Analysis, Go to

http://www.bea.gov/iTable/iTable.cfm?reqid=70&step=1&isuri=1&acrdn=1#reqid=70&step=1&isuri=1

According to Table 1, Missouri's real GDP was close to $190 billion in 1997 and more than $220 billion in 2012. I compute the average annual growth rate by applying the formula: $Y_{T+t} = (1+g)^t Y_T$, where Y_T stands for Missouri real GDP in some particular year represented by the subscript T. After t years have passed, Y_{T+t} is the measure of Missouri real GDP. The average annual growth rate over those t years is measured by g. Based on the data presented in Table 1, Missouri's annual average growth rate between 1997 and 2012 was 1.03 percent, or $g = 0.0103$.

Here, I begin to construct the control values of Missouri real GDP for each year between 2012 and 2037. I assume that Missouri's real GDP can be computed from the following equation: $Y_t = 1.010344 * Y_{t-1}$, where Y is state real GDP. I initialize this forecast with $Y_{2012} = \$221{,}702$. Note that formula forecasts that $Y_{2037} = \$286{,}749$ million and $Y_{2024} = \$245.732$ million.

The *Ak* model yields a very simple expression for the average economic growth rate. In equilibrium, Ireland (1996) derives the economy's growth rate as $(1+g) = (\beta R)^{\frac{1}{\sigma}}$, where β stands for the rate at which people discount future economic outcomes, *R* is the gross after-tax real return and σ is the rate at which people value future consumption relative to present consumption. Armed with the value of Missouri's real GDP growth rate, I follow the convention and use $\beta = 0.96$. Here, the gross after-tax real return is represented by $R = (1-\tau)(A+1-\delta)$, where *A* is the rate at which physical and human capital are transformed into output (the *A* I am looking for), τ is the marginal income tax rate, and δ is the rate at which capital depreciates. Here, I used $\tau = 0.43224$, which is the sum of the maximum federal marginal income tax rate plus the Missouri maximum marginal income tax rate after revising for the deductibility of federal income taxes. Following convention, I use $\delta = 0.1$ and $\sigma = 1.5$. With these values, I compute $A = 0.863236$.

Missouri's 2012 real GDP is $221.702 billion with Noranda's Smelter productive capacity. The market value of aluminum produced at the Noranda Smelter is $626.371 million. (The production value is the product of 589 million pounds of aluminum and the sum of the fabrication premium, the London Metal Exchange (LME) cash price and the Midwest premium, where each price is measured per pound of aluminum. I assume that there would be a 20 percent reduction in employment and production in 2014. The facility would operate at this 80-percent capacity rate until subject to shut down **_____**. With the loss of production at the New Madrid Smelter, Missouri's real GDP is $226.187 billion in 2014 compared with $226.312 with the Noranda Smelter fully operational. **_____**, the Noranda Smelter is subject to complete shut down, with the remaining $626.371 million in production ending. I assume the 2014 "treatment" value grows at the rate of 1.03 percent each year for twenty-five years. For completeness, note that the "treatment" value of Missouri real GDP is $Y^{\dagger}_{2037} = \$285.967$ billion and $Y^{\dagger}_{2024} = \$245.063$ billion, where $Y^{\dagger}$ denotes the treatment level of Missouri GDP without the Noranda physical capital.

With two values of Missouri GDP, the economic impact of the Noranda Smelter over the next twenty-five years is the discounted sum of the differences between projected Missouri GDP with Noranda's physical capital and the projection in which Noranda's physical capital is omitted. More concretely, $\sum_{t=T}^{T+25} \rho^{t-T}(Y_t - Y_t')$, where ρ is the discount factor, or the rate at which one discounts the future levels of Missouri GDP. Here, I use ρ = 0.96. Applying this formula, I compute the discounted sum of Missouri's foregone GDP associated with Noranda's physical capital lost, which is $8.917 billion over the next twenty-five years. For a ten-year span after the initial plant-size reduction, the discounted sum of foregone state GDP is $3.646 billion.

A. Net General Revenue lost

Once the economic impact in terms of foregone state GDP is computed, it is straightforward to compute the impact on Missouri's net general revenue. Net general revenue funds include individual income taxes paid to Missouri, corporate income taxes paid to Missouri and franchise taxes. Here, net refers to amounts after refunds. On average, Missouri's net general revenue fund receives 3.8 cents per dollar of average amount of state GDP. I multiply 0.038 times the loss of Missouri real GDP to compute the expected loss to state net general revenues over the next twenty-five years. My calculations indicate that the present value of Missouri state government would realize a $338.87 million loss over the next twenty-five years if the Noranda Smelter is subject to shut down **_____**. Over the ten-year span, Missouri state government would expect to see the discounted sum of net general revenues decline by $138.55 million.

B. Other taxes

In addition, Noranda reports that in 2013, it paid $3.724 million in property taxes on tangible personal property and real estate. This $3.724 million is owed on the value of land, machines and equipment held by Noranda in 2012. When the Noranda Smelter is subject to shutting down **_____**, I assume the property tax base will shrink. One scenario,for example, is that the property tax on unused land goes to zero. In this scenario, I assumed that the tax bill would have grown at the same rate as the

Missouri state GDP; that is, 1.03 percent. I applied this growth rate in the property tax bill for the period **_____**. I discounted the future tax liabilities at the same rate as I did in the case of the foregone state GDP.

A more likely scenario is that with the shrinking property tax base, the local government tax burden will be shifted to those households and businesses that remain in the taxing jurisdiction. The harm, therefore, will not be borne by the local government, but the tax bill will shifted onto those properties in the tax jurisdiction. By raising their property tax bills, the people and businesses would realize a reduction in their disposable income and a reduction in their personal expenditures; in other words, the residents and businesses would not be able to spend as much on cars, foods, and new equipment, for instance.

Table 2 summarizes the cost to the state and local governments in the form of lost tax receipts. The upshot is that if the Noranda New Madrid Smelter were closed, there are costs in the form of foregone state GDP. Because the Missouri economy shrinks, there are fewer taxes collected by both state and local governments. After discounting, the sum of lost state revenues is estimated to be more than $380

Table 2

Summary of Tax Effects
Based on Closing Noranda's New Madrid Smelter

Tax Category	Present value summed over 25 year period	Present value summed over 10 year period
Net General Revenue foregone	$338.87 million	$138.55 million
Property Tax (not collected)	$51.45 million	$20.24 million

million over a generation and more than $158 million over the first ten years after the plant reduction.

C. **Unemployment insurances benefits**

If the Noranda Smelter were subject to closure **_____* *, there would be additional costs to Missouri state government in the form of unemployment insurance claims made by workers separated from

work. The average unemployment duration is 9.5 weeks.[1] Missouri's unemployment benefits are computed based on the worker's quarterly wages: specifically, a workers weekly benefit amount (WBA) will be 4% of the average of your two highest quarters, but cannot be more than $320.

While I do not have data on the individual worker's salaries at Noranda, officials tell me that the average salary for hourly Noranda employees is $60,000 in 2008. Average salaries have not fallen at the facility since that time. Based on this data, the workers average quarterly wage is $15,000. Weekly unemployment benefits in Missouri are calculated as 4 percent of average quarterly salary or $320, whichever is smallest. Since 0.04 times $15,000 is $600, I assume that each of the 200 employees at the Noranda Smelter in New Madrid, Missouri will receive weekly benefits equal to $320 when laid off in 2014. I refer to this as the first round of layoffs. I then apply the median number of weeks of benefits, which was 16.3 weeks according to the Bureau of Labor Statistics in October 2013, finding that expected weekly unemployment insurance benefits paid to these workers in 2014 would be $1,043,200. If I use the cyclically-adjusted mean duration instead of the median duration, the expected unemployment insurance benefits would be $2,310,400 because the average duration is 36.1 weeks.

In the second round of layoffs, the remaining 688 employees will be laid off. If the (unconditional) expected unemployment spell **_____** is 9.5 weeks, the unemployment insurance benefits paid to Noranda workers will be $2.09 million. If the unemployment spell lasts for 36.1 weeks with benefits paid each week, the expected benefit will be $7.95 million.

[1] Note that the 9.5 is the unconditional average number of weeks that a person is unemployed. In other words, the average duration is not conditional on the current state of the aggregate United States' economy. According to data published by the Bureau of Labor Statistics, the average duration of an unemployment spell is 26.9 in October 2009. The mediation duration is 16.3 weeks. See http://www.bls.gov/news.release/empsit.t12.htm for these data.

Table 3

Expected Unemployment Insurance Benefits

Employee category	Unconditional Mean unemployment duration = 9.5 weeks	Median unemployment duration = 16.3 weeks	Cyclically -adjusted Mean unemployment duration = 36.1 weeks
1st round (2014)	$608,000	$1,043,200	$2,310,400
2nd round **____**	$2,091,520	$3,588,608	$7,947,776

Thus, for the case in which the Noranda New Madrid Smelter were subject to closure, the State of Missouri would face an increase in its total unemployment insurance benefits, ranging from $2.7 million to $10.3 million depending on the macroeconomic conditions under which the facility closing occurred.

IV. Summary

In this report, I have applied standard economic theory to compute the effect that eliminating Noranda's New Madrid Smelter would have on the Missouri economy. I treat the case in which the physical capital employed by Noranda is not immediately re-employed.

For the twenty-five year period after the smelter is subject to closure **_____**, the discounted sum of lost state GDP is $8.917 billion. For the first ten years after plant reduction, the amount is $3.646 billion. First, state and local government revenues are not paid. The discounted sum of lost net general revenue paid to the state is $338.87 million over the twenty-five year period and $138.55 million over a ten-year period. Second, local property taxes are also reduced by $51.45 million over a twenty-five year period if the lost revenue from Noranda is not made up by increased collections on remaining taxpayers. Over a ten-year period, the amount is $20.24 million lost revenue from Noranda is not made up by increased collections on remaining taxpayers. Third, the state will incur some costs in the form of unemployment

insurance benefits. If the smelter shutdown occurred, on average, the state would expect to pay $2.7 million in unemployment insurance benefits. If, however, the smelter shutdown occurred with the current expected unemployment duration equal to its current mean value, the state would expect to pay $10.3 million in unemployment insurance benefits to Missourians.

Bibliography

Ireland, Peter N., 1994, "Supply-side economics and endogenous growth," *Journal of Monetary Economics*, June, 33(3), 559-71.

Rebelo, Sergio T., 1991, "Long run policy analysis and long run growth, *Journal of Political Economy,* June, 99(3), 500-21.