The Effects of Non-Existent Property Ownership Rights Within the Electricity Production Sector on Labor Force Participation in the Dominican Republic

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Abstract

The labor market in the Dominican Republic is in disarray. There has been a high rate of unemployment and a very high rate of non-participation within the labor force for years. Output growth has been steady in manufacturing, telecommunication, and financial services, and new jobs have been added in the service sector consistently, however these gains have led to no real increase in available quality jobs and wage stagnation (Williams & Adedeji, 2004). Abdullaev and Marcello (2013) describe a dichotomous approach to solving the problem; through targeted education for the long term and through product market reforms in the near term.

The energy sector in the Dominican Republic is a prime example of an area where reforms are needed to improve the operating environment to spur and sustain growth. At present the losses in transmission and distribution are significantly higher than in most places as a result of fraud (Smith 2004). Until recently it has not been against the law to steal electricity (Enerdata 2011). The rationale being that if electricity is a basic human right we cannot punish those who attempt to gain it. This lack of property law within the context of electricity underpins a significant failure by the government when viewed from the point of the electricity producers. Property ownership is a fundamental concept of free markets. Without ownership rights there is no (or limited) ability to charge for goods produced with that property. Electricity is a commodity property and without the ability to effectively charge for its consumption the producers have struggled.

Overview

The electricity market is dominated by three producers (one government owned and two private) and two distributors (again, one government owned). The US State Department reports in "Dominican Republic" (2015) that some electricity producers are severely undercapitalized and are often unable to purchase fuel. This failure of the competitive free market due to regulation failure reduces the demand for labor within the sector by reducing profit from existing, and incentive for future, generation capacity. Although there are several hydro, wind, and gas plants being constructed, they are small in scale, and these renewable plants receive significant offsets from the government (enough to offset the downside of the inability to gain rents from produced output).

Resolving the ownership rights problem in the electricity sector should act grow the economy as a whole. Those jobs have failed to grow in recent years with the growth in manufacturing, telecommunications, and financial. Real wages in these industries have likewise stagnated. These forces combine to reduce the incentive to work.

Abdullaev and Marcello (2013) report that the education intensity for the electricity, gas, and water sector is the fourth highest, indicating that within the sectors evaluated, this one has the fourth highest rate of at least high school completion. Their regression analysis shows that for every year increase in educational attainment a male is 3.2% more likely and a female 10.8% more likely to participate in the labor force. These new jobs created through growth within the electricity sector will pull those workers (higher educated) back into the labor force. This has long range effects on the economy as a whole. Higher labor force participation increases total

output and wages, increasing investment and consumption, increasing future capital stock, which can be then used to further increase output.

Policy Evaluation

One of the underlying tenets of Keynesian economics is the idea that government fiscal policy should act to shore up the economy through spending during recessions and rebuild its surplus through reduced spending during times of growth. To some degree the government of the Dominican Republic has done that within the electricity sector by providing tax offsets for new generation (renewable). Another key tenet of Keynesian economics is that unemployment can only occur through market inefficiencies. This is a case where that may hold true, although the New Keynesian models offer the reason for unemployment as sticky prices and wages, this is a case where there is a clear link between policy and growth. Government failure to secure ownership rights for electricity produced has created the market environment that has made it nearly impossible for the existing producers to expand without help (tax assistance), and in some cases to even pay their bills (United States Department of State, 2015). This environment does not promote the hiring of new employees. Although this is only one segment, and Keynes preferred to view the economy as a whole, the actions within this segment may speak to the overall climate in the economy.

The monetarist view would be that: an increase in real wages through expanded labor force participation should result in increased aggregate demand. Higher consumption increases the liquidity of the market, increasing the availability of money. Without government intervention the increased liquidity will result in inflation (although this would be moderated by the fact that currently the economy is in an underemployment equilibrium). Government

intervention should be to increase interest rates or sell securities, thus reducing the money supply, thus curbing inflation. Attempting to correct the underemployment through stimulative policies (loosening money supply) would not resolve the underlying policy related cause (property rights) and would only act to exacerbate any subsequent inflationary pressure. This policy, however is not directly related to the policy of fixing property rights, but rather to the outcome of that change.

The neo-classicalist view would be that: this policy amounts to an actual change in labor effectiveness and in labor (Rapaczynski, 1996). Business cycles result from shock to the various factors of output, however real growth can only be achieved through the increased effectiveness of labor (assuming that labor supplied is maximized). In this scenario, labor supplied is not maximized as labor force participation is low. Unemployment is much greater than its natural rate. As opposed to Keynesians, neo-classicalists don't see labor as the product (demanded by firms and supplied by workers) but rather see jobs as the product, supplied by firms and demanded by workers (Hoover, 1990). By shifting the supply and demand to the opposite sides, many of the Keynesian problems with unemployment go away (specifically that there is no unemployment without market inefficiencies). In this case there truly are market inefficiencies caused by the government, so both sides see the problem. Reducing unemployment to its natural rate (those changing jobs, transitioning from school, raising children, etc.) acts to increase the amount of available labor. Increasing the number of high paying high education required jobs through the policy discussed above also acts to increase the aggregate effectiveness of labor, which we have discussed causes real output growth. Beside the increase in labor supplied, there is an increase in its effectiveness as well. Improving the policy that allows the labor to produce a

profit earning output acts to cause real growth. Both of these impacts are in the same direction and will thus act to enhance the effect of the other.

All three of the models predict that increasing labor force participation will result in real growth of the economy. Although they predict it for different reasons, and in the Keynesian case, go so far as to say that the unemployment shouldn't be possible in the first place (without governmental failure), they all tend to agree that this policy (ownership rights) will have a positive effect. The idea of ownership rights are so fundamental to the notion of a free market, that nearly all practitioners agree that the very idea of the free market fails without it (Rapaczynski, 1996). As such, any of the three choices would help us arrive at the final destination. Improved property rights can be viewed as a step increase in technology (innovation, labor effectiveness, etc.).

Solow's growth model (and those built on it) suggest that long term growth can only be accomplished through improvements in labor effectiveness (Romer, 2012), thus if we treat property ownership rights as an improvement in labor effectiveness, growth should follow. Using that assumption the implications of such a change will be investigated using the simplified Real Business Cycle model described by Romer (2012, p. 201). This model ignores governmental spending and assumes depreciation of 100% per period; although these do not reflect the real world, they do provide a means for solving for equilibrium changes caused by changes to inputs that should at least approximate the scale and direction of the resultant overall change.

Macroeconomic Forecast

The model suggested by Romer (2012, p.201) acts as the starting point for the forecast that this paper will develop in response to correcting the property ownership rights issue

described. As described previously, the improvement in property rights is assumed to equate to an improvement in labor effectiveness. Romer's baseline real business cycle model specifically excludes governmental actions and assumes 100% depreciation per period. We assume that government intake (taxes) are spent in the same period at 100%, thus eliminating the need to model government actions. We also assume that capital (*K*) in time *t* is a function of output (*Y*) in time *t-1,* by doing so we show capital as being directly equal to savings (*s*) and eliminate the need to model interest or depreciation. This model is not indicative of real world conditions, however, as it is focused on a specific sector, and accounts for a small percentage of aggregate output, it should yield results on the appropriate scale and trending in the correct direction.

Treating output as a Cobb-Douglas function (with constant returns to scale) and given real GDP, population, and labor force participation rates leaves initial capital, labor effectiveness, and output elasticities as the only unknowns. Romer's assumption (2012) of 100% depreciation reduces capital to the output times the saving rate in the previous period, as we have GDP and saving rate, we can calculate capital level. Data obtained from the World Bank's website (http://databank.worldbank.org/data/databases.aspx) provides GDP, saving rate, population, and labor force participation rate for 2000 to 2015. The 2000 GDP and saving rate data were then used to estimate 2001 capital level (all values in 2015 US Dollars) at US$4,329,403,750. This same formulation was used to estimate capital for all periods (using an average saving rate and projected outputs capital is estimated for future periods as well, see Appendix A). With capital solved for, it was next assumed that labor effectiveness in 2001 (t=1) was 10000 (this allowed capital output elasticity to be near 1/3 as suggested by Romer (2012)). At this point the only variable left in the 2001 production function was output elasticity, with production having been assumed to take the form $Y_t = K_t^{\alpha}(A_t L_t)^{1-\alpha}$ solving for output elasticity

is a simple logarithmic equality. This output elasticity is assumed to be constant for all time periods, with this assumption, and knowing capital, labor, and output for 2015, labor effectiveness was solved for. Knowing labor effectiveness (A) in 2015 and in 2001, and assuming a fixed percentage growth rate (as in the Solow growth model) it becomes easy to solve for that rate ($g = \left[\left(\frac{A_{2015}}{A_{2001}}\right)^{\frac{1}{14}}\right] - 1$). This yields a labor effectiveness growth rate of 5.718%. Labor force growth is likewise calculated from actual data (for use in projection date) at 1.52% as is average saving rate at 18.18%.

With all variables calculated or estimated the fit of the model was tested. Output predicted by the model (Y*) was compared to actual GDP. The Solow Residual (Appendix B) was larger than 10% of actual GDP in 2003, 2004, 2005, and 2007, however averaged less than 1% over the 14 year period. Although not a perfect model, the standard deviation for percentage error was 14%, it is on average very close to actual output. Since predicting cyclic variations is not the goal, rather predicting the growth trend as a result of this specific policy change is, this model is found to be acceptable for that purpose. Shocks that result in output not fitting the model are to be expected over a timeframe of 14 years. Variation in labor growth, capital growth, labor effectiveness, savings rate, etc. are to be expected, however, as discussed, since this model is intended to evaluate the trend resulting from a proposed change, these variations from the trend can be ignored.

Having specified the model and established values for all parameters the step change in labor effectiveness resulting from fixing property rights was needed. In Dominican Republic - Distribution Grid Modernization and Loss Reduction Project (2015) the World bank established the electricity sector as having 2014 sales of DR$69855M with lost revenue of DR$40152.87M.

Using an exchange rate of 46.4 DR$/US$ lost revenue amounted to US$865M or approximately 1.35% of GDP. Using the model values for 2014 to solve for the required step increase in labor effectiveness (A) to offset this lost output results in an increase of 1.9764%. Two models are estimated from 2015 onward, one with and one without the step increase in labor effectiveness (Appendix C).

Economic theory suggests that a step increase in labor effectiveness should result in increased overall growth. As opposed to a one time shock, the resultant increase in growth should be persistent. Capital should follow output levels (lagged by one period) and output should stabilize at a level above that which it would naturally reach by a percentage equal to the percentage size of the step increase in labor effectiveness (assuming constant returns to scale, which we have done) (Hoover, 1990 & Romer, 2012). The model specified for this analysis shows output in the form of GDP rising to 1.9764% above its projected non-intervention level within 10 years, capital rising to the same percentage increase lagged by one year from output, and labor effectiveness rising by the same 1.9764% in one year (step increase) and staying at that percentage level above where it otherwise would have been. The results of the model fit in direction and scale with the theory.

This overall growth in the economy, above what it would have grown, will result in decreased unemployment through several means. Increased demand faced by the electricity sector will directly result in increased employment opportunities. The follow on effects felt throughout the economy (increased purchasing power, lower electricity prices, etc.) will have further positive effects on employment. Inflationary pressure will tend to decrease unemployment, however in this case, unemployment is not the issue, but rather low labor force participation. This model assumes that available labor grows at a steady percentage over time

(implicitly assuming a constant labor force participation rate of 64.6%), the growth predicted, however should act to increase labor force participation. As discussed prior the causes of low labor force participation are myriad, however, any change that improves the competitiveness of the wages within the electricity sector will attract workers. Should labor force participation rate rise the effects seen would be amplified by $\Delta L^{1-\alpha}$.

Industry Analysis

Applying the same model as used for the economy as a whole to the electrical sector should reveal a rough estimation of what to expect from that specific portion of the economy. Assuming that capital and labor in the sector are proportional to the whole economy by the same rate that output is proportional (the electrical sector would account for approximately 3.71% of GDP without the lost revenue associated with property rights deficiencies), and assuming that output elasticity and labor effectiveness are the same values should produce a useful prediction over the same time period.

Applying the reasoning above to the 2014 data yields a predicted pre-change output for the sector of US$2,327M versus an actual output of US$2,370M, or a 1.8% discrepancy in predicted versus actual. This suggests that the application of the ratio version of the model to the sector should provide a projection nearly as accurate as that obtained for the economy as a whole. Based on this fact, the same time period (2015 through 2024) has been evaluated. The largest difference between the sector level model and the economy level model is the valuation of labor effectiveness, the 2014 economy level model value produced the 2014 estimation above, so is retained for the pre-policy level. Using the same methodology to determine the post-change labor effectiveness as used for the larger model (working backwards to labor effectiveness by

increasing output by the amount of lost revenue) yields a 26,272% increase in labor effectiveness for this sector. This larger change causes the stabilization time to increase to approximately 15 years and the new output to be about 24,851.02% above where it would have been otherwise (Appendix D).

This drastic increase in billable output will directly result in increased profit for the sector, as with this change all output will be paid for (versus now, where only 63.5% is paid for). This increase in profit will improve the condition for existing firms and create incentive for new firms to enter the market. The increased competition will put downward pressure on prices until a new equilibrium level is attained, the decreased prices will likewise place upward pressure on demand creating more incentive to enter the market. Eventually the rise in demand, will be met by an increase in supply at some new price level below the current level. This reduction in prices will increase the purchasing power for consumers. The influx of cash into the economy will have ramifications for interest rates and inflation, however is assumed to be adequately dealt with by the Dominican central bank.

Conclusion

The correction of property ownership rights has been discussed as a correction for electricity sector woes before. Abdullaev and Estevao (2013), Enerdata (2011), and Dominican Republic - Distribution Grid Modernization and Loss Reduction Project (2015) all specifically call for this policy correction. Smith (2004) describes the effects of electricity theft on an economy and Rapaczynski (1996) makes the case for the importance of property rights as a whole.

The models derived and discussed above make a compelling argument for correcting this market failure. Property ownership is a fundamental upon which free markets are built Rapaczynski (1996), without which there can be no free markets as we know them. In this case the failure to secure property rights for a specific sector has resulted in significant losses to that sector and substantial losses to the economy as a whole.

The models presented are simplistic and ignore large swaths of the economy and the factors that affect growth and stability. This does not reduce their worth, however, as these models are built on solid theory and are intended only to address the impact of a specific change to a specific industry. Since they are so specific in nature, and treat as exogenous so much of the economy their predictions should not be taken as necessarily precise or accurate in scale, but should be treated as accurate in direction. Ceteris Paribas, these models may reflect actual growth, however it is impossible to hold all other things constant. That being said, the general direction and possibly size of the growth created from this change should be reflected within the projections given.

The policy change could be implemented for effectively no cost. The long term effects would need to be monitored by the central bank and inflationary pressure accounted for as desired. Since this is correcting a market failure, and not attempting to force the market to behave contrary to its innate desires, there are few negative side effects to consider. Beyond expanded money supply and the attendant inflation caused by same, the outcomes are positive; increased purchasing power for consumers, lower electricity prices for consumers, more competition, increased profits for producers, and increased labor force participation. As a result, this policy improvement should be enacted as soon as possible.

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Appendix A: Macro variables without policy change

Year	K (est)	L	A	α
2001	$ 4,329,403,750.34	5531372.64	10000.00	0.313414
2002	$ 4,367,985,372.22	5643830.89	10571.79	0.313414
2003	$ 4,654,878,752.96	5757301.00	11176.26	0.313414
2004	$ 4,056,320,940.27	5871433.07	11815.31	0.313414
2005	$ 4,170,093,443.74	5976704.27	12490.89	0.313414
2006	$ 4,545,651,931.83	6081995.26	13205.10	0.313414
2007	$ 5,038,373,408.84	6187322.59	13960.15	0.313414
2008	$ 10,094,252,424.41	6273355.49	14758.37	0.313414
2009	$ 9,775,658,275.06	6358796.64	15602.23	0.313414
2010	$ 9,029,874,136.24	6423791.12	16494.34	0.313414
2011	$ 10,592,544,277.80	6507614.01	17437.46	0.313414
2012	$ 10,378,492,951.82	6590618.52	18434.51	0.313414
2013	$ 10,279,685,823.98	6672633.95	19488.57	0.313414
2014	$ 10,994,375,088.58	6753457.17	20602.89	0.313414
2015	$ 11,719,382,994.77	6832925.76	21780.94	0.313414
*2016	$ 12,196,594,500.23	8680629.46	23026.34	0.313414
*2017	$ 15,122,305,483.70	11068189.36	24342.95	0.313414
*2018	$ 19,857,133,894.85	14164682.09	25734.84	0.313414
*2019	$ 26,615,033,724.42	18195599.94	27206.32	0.313414
*2020	$ 35,995,585,611.88	23462808.90	28761.94	0.313414
*2021	$ 48,947,795,142.81	30371962.80	30406.50	0.313414
*2022	$ 66,851,343,695.83	39470305.31	32145.10	0.313414
*2023	$ 91,675,006,434.74	51499001.68	33983.11	0.313414
*2024	$ 126,221,352,716.40	67465874.48	35926.22	0.313414

*Projections based on fixed percentage growth rates for population and labor effectiveness.

Appendix B: Solow Residuals

Year	Y* (est)	Y (act)	Solow Residual (Y-Y*)	Residual %
2001	24892595799	24892595799	-0.26203537	0%
2002	26294153898	26571659051	277505152.7	1%
2003	28250969108	21277171990	-6973797118	-33%
2004	28492585975	22039210346	-6453375629	-29%
2005	30225660100	34004081037	3778420937	11%
2006	32651298216	35952890849	3301592634	9%
2007	35449310132	44073886687	8624576555	20%
2008	46226232999	48152993004	1926760006	4%
2009	47988463886	48193458083	204994196.4	0%
2010	48971955110	53864484468	4892529359	9%
2011	53965784747	58361928552	4396143805	8%
2012	56195159634	60595109805	4399950171	7%
2013	58703566622	61198323069	2494756447	4%
2014	62803409394	63968906782	1165497388	2%
2015	67103263863	67103263863	0.39263916	0%

Appendix C: Growth Estimates

Year	GDP	GDP*	dY%	K (est)	K*	dK%	L	L*	dL%	A	A*	dA%
2001	$ 24,892,595,798.72			$ 4,329,403,750.34			5531372.64			10000.00		
2002	$ 26,571,659,051.21			$ 4,367,985,372.22			5643830.89			10571.79		
2003	$ 21,277,171,990.41			$ 4,654,878,752.96			5757301.00			11176.26		
2004	$ 22,039,210,346.13			$ 4,056,320,940.27			5871433.07			11815.31		
2005	$ 34,004,081,037.34			$ 4,170,093,443.74			5976704.27			12490.89		
2006	$ 35,952,890,849.45			$ 4,545,651,931.83			6081995.26			13205.10		
2007	$ 44,073,886,687.23			$ 5,038,373,408.84			6187322.59			13960.15		
2008	$ 48,152,993,004.29			$ 10,094,252,424.41			6273355.49			14758.37		
2009	$ 48,193,458,082.84			$ 9,775,658,275.06			6358796.64			15602.23		
2010	$ 53,864,484,468.23			$ 9,029,874,136.24			6423791.12			16494.34		
2011	$ 58,361,928,552.03			$ 10,592,544,277.80			6507614.01			17437.46		
2012	$ 60,595,109,805.05			$ 10,378,492,951.82			6590618.52			18434.51		
2013	$ 61,198,323,068.97			$ 10,279,685,823.98			6672633.95			19488.57		
2014	$ 63,968,906,782.07			$ 10,994,375,088.58			6753457.17			20602.89		
2015	$ 67,103,263,863.39	$ 68,011,028,641.33	1.3528%	$ 11,719,382,994.77	$ 11,719,382,994.77	0.0000%	6832925.76	6832925.76	0.0000%	21780.94	22211.41	1.9764%
2016	$ 83,199,950,204.98	$ 84,681,346,468.63	1.7805%	$ 12,196,594,500.23	$ 12,361,588,544.71	1.3528%	8680629.46	8680629.46	0.0000%	23026.34	23481.43	1.9764%
2017	$ 109,250,044,779.66	$ 111,342,134,571.77	1.9150%	$ 15,122,305,483.70	$ 15,391,561,977.07	1.7805%	11068189.36	11068189.36	0.0000%	24342.95	24824.06	1.9764%
2018	$ 146,430,680,359.10	$ 149,296,510,873.60	1.9571%	$ 19,857,133,894.85	$ 20,237,389,181.76	1.9150%	14164682.09	14164682.09	0.0000%	25734.84	26243.46	1.9764%
2019	$ 198,040,631,683.86	$ 201,942,713,872.76	1.9703%	$ 26,615,033,724.42	$ 27,135,923,032.62	1.9571%	18195599.94	18195599.94	0.0000%	27206.32	27744.02	1.9764%
2020	$ 269,301,140,815.86	$ 274,618,459,241.18	1.9745%	$ 35,995,585,611.88	$ 36,704,822,561.39	1.9703%	23462808.90	23462808.90	0.0000%	28761.94	29330.38	1.9764%
2021	$ 367,802,943,316.12	$ 375,069,944,609.99	1.9758%	$ 48,947,795,142.81	$ 49,914,263,432.56	1.9745%	30371962.80	30371962.80	0.0000%	30406.50	31007.45	1.9764%
2022	$ 504,377,852,876.69	$ 514,345,335,951.59	1.9762%	$ 66,851,343,695.83	$ 68,172,183,591.11	1.9758%	39470305.31	39470305.31	0.0000%	32145.10	32780.41	1.9764%
2023	$ 694,445,054,831.88	$ 708,169,519,788.45	1.9763%	$ 91,675,006,434.74	$ 93,486,682,085.88	1.9762%	51499001.68	51499001.68	0.0000%	33983.11	34654.75	1.9764%
2024	$ 960,001,235,965.56	$ 978,974,327,907.30	1.9764%	$ 126,221,352,716.40	$ 128,715,892,090.07	1.9763%	67465874.48	67465874.48	0.0000%	35926.22	36636.25	1.9764%

All values in 2015 US Dollars.

Appendix D: Electricity Sector Projection

	2015*	2016*	2017*	2028*	2029*
	with step increase				
L*	253246.556	306001.57	370811.85	3758559.22	4731708.64
K*	434351768.339	19997826429.59	78566625126.29	2333045417318.15	3089594852168.03
A*	5434566.151	5745306.52	6073814.56	11196778.81	11836993.89
alpha	0.313	0.31	0.31	0.31	0.31
Y*	110024107431.497	432258117343.85	786779094397.35	16998343151517.80	22587724255642.00
	without step increase				
L*	253246.556	306001.57	370811.85	3758559.22	4731708.64
K*	434351768.339	452038506.74	541516526.24	9350515032.07	12382644620.25
A	21780.936	23026.34	24342.95	44875.03	47440.92
alpha	0.313	0.31	0.31	0.31	0.31
Y*	2487026947.853	2979317410.77	3737330814.38	68126875027.18	90528267327.49
% difference	43.2392100039	144.0862925117	209.5189862696	248.5100963421	248.5101797755

All values in 2015 US Dollars.