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Macro-Growth Model To Calculate the Effects of Legalization

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This methodology describes the models and the formulas used to simulate the effects of regularization of undocumented workers in the United States, as reported in "A Pathway to Citizenship for Undocumented Immigrants Would Boost U.S. Economic Growth."[1] Specifically, the authors used a growth model, following Charles I. Jones and Dietrich Vollrath's methods in *Introduction to Economic Growth: Third Edition*,[2] considered in its long-run equilibrium (balanced growth path), and they performed comparative statics in the situation with and without the regularization.

This model provides the evaluation of human capital, wage income, and gross domestic product (GDP) in the scenario with the regularization (REG) relative to a counterfactual without regularization (NOREG) assuming that the other variables and factors continue on their long-run growth path.

1. Production

The authors consider an economy, representing the United States, at a certain point in time, where total output, Y, at time, t, is produced using human capital, H, physical capital, K, and productivity, A, combined in a Cobb-Douglas production function with an elasticity of output to employment, α, and constant return to scale to physical and human capital. The formula is as follows:

$$Y_t = AH_t^{\alpha} K_t^{1-\alpha} \quad (1)$$

The aggregate production can be expressed in per-person terms, and calling the total population of the United States as N, then income per person, y=Y/N, can be written as:

$$y_t = \frac{AH_t^{\alpha} K_t^{1-\alpha}}{N_t} \quad (2)$$

2. Human capital

Human capital is a combination of employment, L, and schooling per worker, h, which depends on average years of schooling and average efficiency, θ, which depends on average skills, knowledge of language, and other individual abilities. Separating the employment in documented (subscript D) and undocumented (subscript U) workers, as the focus of the analysis is to understand the change in efficiency/human capital of undocumented workers as a consequence of the legalization, total human capital can be written as follows, where θ_D and $h_t=e^{sy}$ are the average efficiency and human capital from schooling of the average workers:

$$H_t = \theta_D h_t[(p_U n_U + (1 - n_U)]L_t \quad (3)$$

The term p_U, which is smaller than 1, captures the difference in human capital and productivity between undocumented and documented. In part, it is a difference in schooling and in part in efficiency. This term captures both. The parameter n_U is the share of employment that is undocumented. L_t is total employment. The parameters in formula (3) can be measured before the regularization (NOREG), and then the authors simulate their value after the regularization (REG) and evaluate the change in percentage terms. In particular, the authors use the pre-regularization current ratio of wages between documented and undocumented workers to estimate p_U, the relative level of human capital for undocumented versus documented. When the authors simulate the impact of legalization, they increase this difference of the percentage gain due to the estimated gains in productivity from regularization. Even after regularization, the term p_U will remain smaller than 1 due to differences in human capital and productivity between regularized and documented workers. In this model, the authors assume perfect substitutability in production between documented and undocumented, so their difference in wages only derive from their difference in efficiency, productivity, and schooling.

3. Productivity and externalities

Following the literature on human capital externalities,[3] the authors consider that total factor productivity, A, depends on average schooling among employed workers, with an elasticity indicated by φ, which, based on the estimates in Susana Iranzo and Giovanni Peri's "Schooling Externalities, Technology, and Productivity: Theory and Evidence from U.S. States," the authors set to 1. This captures the positive productivity effect of increasing average years of schooling on learning, efficiency, technology adoption. So specifically, while average human capital also depends on average efficiency (θ), productivity depends on technology that grows at an exponential rate as in the classic growth model, A_0e^{gt}, and on the average human capital from schooling (only), not on efficiency, through the externality:

$$A_t = A_0 e^{gt} h_t^{\varphi} \quad (4)$$

with

$$h_t = [(e^{\gamma S_U} n_U + e^{\gamma S_D}(1 - n_U)] \quad (4.1)$$

The parameter h_t represents the average human capital from schooling only in the economy, derived from averaging the schooling of documented and undocumented. The "conservative" assumption of the model is that only the part of human capital coming from schooling (h) translates in productivity externality. The one coming from efficiency and from reducing the productivity penalty of undocumented, while it increases their individual human capital, does not contribute to the externality. The fraction of undocumented in employment will be equal to 4.4 percent. Those covered by the Dream Act are about 28 percent of undocumented. Those who are employed, younger than 30, and with less than a college education are about 25 percent of undocumented workers. These groups will increase their schooling by two years over 10 years after the reform. Hence this channel will be important in generating productivity effects.

4. Physical capital

To calculate the medium- and long-run effect, the authors assume that physical capital investments adjust so as to keep the real interest rates r (that is to say, the returns to physical capital) constant in the long run and equal to the marginal productivity of physical capital, net of depreciation, δ. This implies that on such a path, physical capital will be proportional to human capital and equal to:

$$K_t = \left[\frac{(1-\alpha)A_t}{r+\delta}\right]^{\frac{1}{\alpha}} H_t \quad (5)$$

Plugging this in the production function, collecting the constant terms (not affected by the legalization reform) in an initial term C, GDP is equal to the following, where A_t is defined as in (4) and H_t is defined as in (3):

$$Y_t = C A_t^{\frac{\alpha+1}{\alpha}} H_t \quad (6)$$

The term A_t is raised to a power larger than 1 because it captures the effect of productivity and the response of physical capital investment, both of which contribute to increase the productivity of human capital. The expression is also linear in human capital.

5. Wages

In the medium- and long-run average wages, w_t will be equal to the marginal productivity of the person with average human capital, hence equal to:

$$w_t = \frac{\partial Y_t}{\partial L_t} = CA_t^{\frac{\alpha+1}{\alpha}} \frac{H_t}{L_t} \quad (7)$$

The wage of a specific group, such as undocumented or documented, will equal the average wage times the ratio of the human capital for that group relative to the average: $\theta_D p_U h_U/(H/L)$ and $\theta_D h_D/(H/L)$.

6. Simulated effects of regularization

Using the simple model of balanced growth above, it is therefore possible to analyze the effect of the regularization by calculating the ratio of a variable (such as Y, y, w, wH) when the authors include the parameter values with regularization (REG) relative to the variable when they consider parameter values without the regularization (NOREG). In particular, those ratios are as follows:

$$\frac{y_{REG}}{y_{NOREG}} = \frac{Y_{REG}}{Y_{NOREG}} = \left(\frac{A_{REG}}{A_{NOREG}}\right)^{\frac{1+\alpha}{\alpha}} \left(\frac{H_{REG}}{H_{NOREG}}\right) \quad (8a)$$

and

$$\frac{w_{REG}}{w_{NOREG}} = \left(\frac{A_{REG}}{A_{NOREG}}\right)^{\frac{1+\alpha}{\alpha}} = \left(\frac{h_{REG}}{h_{NOREG}}\right)^{\varphi\frac{1+\alpha}{\alpha}} \quad (8b)$$

7. Parameter changes due to regularization

In the one to five years after regularization, there are two main effects only:

1. The parameter p_U in formula (3), capturing the difference in efficiency and human capital between undocumented and documented, is initially set to equal the ratio of undocumented to documented wages as of 2019–2020 (CPS estimates, equal to 0.72). Then this value is increased in five years after regularization by a total of 10 percent (to become 0.79) as consequence of the regularization. This will increase the average human capital of regularized undocumented and their wages, filling part of the wage gap with U.S.-born workers. The share of undocumented in employment used, also estimated from CPS 2019–2020, is 4.4 percent.

2. The second effect (embodied in the formulas) increases by the same proportion as average human capital as physical capital has responded to the stimulus of higher worker productivity.

In the five to 10 years after regularization with a naturalization possibility, there are three additional effects:

1. Penalty of regularized further reduces (p_U grows) by an additional 5 percent due to better language skills and an extra 5 percent due to naturalization skill premium.

2. More importantly, either the young working undocumented (25 percent of all working undocumented) or all Dreamers, working and not working (28 percent of the working undocumented) increase their schooling by two years. This value is equal to the difference in average schooling between documented and undocumented individuals, and it is the requirement to get citizenship in the Dream Act. As a consequence, their human capital due to schooling increases by a factor of $\exp(2\gamma)$ in formula (3), where γ is the percentage return to one extra year of tertiary education, which Autor et al (2019) estimate at 0.10.[4] Similarly, the average schooling in total factor productivity increases in formula (4), and the parameter φ is set to be equal to 1, as in Iranzo and Peri's "Schooling Externalities, Technology, and Productivity: Theory and Evidence from U.S. States."

3. As before, the physical capital adjusts so that the effect of higher productivity is magnified as shown in formula (8), and average wages (and wages of documented) now are affected.

8. New employment and jobs due to regularization

The authors did not incorporate any complementarity between documented and undocumented. In any case as regularization does not imply a change in the supply of immigrants, just a change in their productivity, the authors think the complementarity channel would be minor in this case.

The employment creation effect is instead generated by the increase in average real wages, which bring some people into employment, from the working-age population, which is unchanged. To obtain such a number, the authors take the ratio of average wages with and without the regularization and assume that the ratio of employment to population responds to this with an elasticity μ=0.27, which is the elasticity of labor supply estimated for the United States in George J. Borjas and Hugh Cassidy's "The wage penalty to undocumented immigration."[5] Hence the value of the employment difference with regularization in percent is:

$$\frac{L_{REG}}{L_{NOREG}} = \left(\frac{h_{REG}}{h_{NOREG}}\right)^{\varphi\frac{1+\alpha}{\alpha}\mu} \quad (9)$$

Once all the differences between the case with regularization and without are calculated as percentage values, the authors transform them into dollar and jobs amount by multiplying them for the 2020 value of the variable in $ or in units (if it is jobs).

5 reform scenarios

Scenario 1: Legalization and naturalization of all employed undocumented. This implies legalization of 6.6 million people. They will all experience the increase in efficiency, and those young (under age 30 and not college educated) among them, equal to about 1.5 million, will receive a bump in their schooling over the next 10 years by two years. This represents the strongest long-run effect on productivity. The increase in human capital and associated physical capital will do the rest of the effect. Higher wages for all workers will drive more employment.

Scenario 2: Legalization and naturalization of all undocumented employed in essential sectors. This implies legalization of 5 million undocumented. Among them, those who are younger than 30 (about 1.25 million) will have the extra education bump.

Scenario 3: Legalization of Dream Act and Temporary Protected Status (TPS) individuals. This includes those who arrived at age 18 or younger up to 2021 and are in school or have attended high school. This number totals 2 million people. All of them are young and will respond to the regularization increasing their schooling.

Scenario 4: Legalization of Dream Act and TPS individuals and essential workers. This includes a total of 6 million people, of whom 2.5 million are young people.

Scenario 5: Legalization of Dream Act and TPS individuals and employed. This involves about 7.2 million people, of whom about 2.7 million are young people.

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Endnotes

1 Giovanni Peri and Reem Zaiour, "A Pathway to Citizenship for Undocumented Immigrants Would Boost U.S. Economic Growth" (Washington: Center for American Progress and University of California, Davis, Global Migration Center, 2021), available at https://www.americanprogress.org/?p=500433.

2 Charles I. Jones and Dietrich Vollrath, *Introduction to Economic Growth: Third Edition* (New York: W.W. Norton and Co., 2013).

3 Enrico Moretti, "Human capital externalities in cities," in J. Vernon Henderson and Jacques-François Thisse, eds., *Handbook of Regional and Urban Economics vol. 4* (Amsterdam: Elsevier, 2004); Susana Iranzo and Giovanni Peri, "Schooling Externalities, Technology, and Productivity: Theory and Evidence from U.S. States," *The Review of Economics and Statistics* 91 (2) (2009): 420–431, available at https://www.jstor.org/stable/25651346?seq=1.

4 David Autor, Claudia Goldin, and Lawrence F. Katz, "Extending the Race between Education and Technology" (Cambridge, MA: National Bureau of Economic Research, 2020), available at https://www.nber.org/papers/w26705.

5 George J. Borjas and Hugh Cassidy, "The wage penalty to undocumented immigration," *Labour Economics* 61 (C) (2019), available at https://www.sciencedirect.com/science/article/abs/pii/S0927537119300831.