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Economic complexity and human development: a note

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Abstract

Existing studies establish a positive effect of the mix of products that a country produces on that country's pattern of economic development and growth. But “there is more to life than income”, hence, does this product mix also predict the people's “quality of life”? The theoretical arguments point out both positive and negative effects, but lack empirical support. In this note, we attempt to address these arguments by examining the impact of economic complexity on countries' social development. Utilizing a dynamic panel data econometric framework, we find no evidence of a causal effect of economic complexity on human development.

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1. Introduction

The development literature views economic development and growth as a process of structural transformation of the productive structure and emphasizes the catalytic role of structural change and economic diversification for long-term growth (Rosenstein-Rodan, 1943; Lewis, 1954; Rostow, 1959, 1990; Kuznets, 1966; Nurkse, 1966; Kaldor, 1967; Chenery and Taylor, 1968; Fajnzylber, 1990; Klinger and Lederman, 2006; Hidalgo et al., 2007).

In a series of recent papers, Dosi et al. (1988), Saviotti (1996), Dopfer et al. (2004), Saviotti and Pyka (2004), Frenken and Boschma (2007), Hanusch and Pyka (2007), Frenken et al. (2007) Stirling (2007), Hidalgo et al. (2007), Saviotti and Frenken (2008), Hidalgo and Hausmann (2009), Felipe et al. (2012), explain economic development as a process of learning how to produce more complex products, focusing on productive capabilities and innovation, which in turn leads to creative destruction and transmutation of the economic system.

Despite all this body of work arguing in favor of a connection between a country's productive structure and the country's subsequent pattern of economic development and growth, emphasizing the role of structural transformations for moving from extractive, agricultural sectors to more sophisticated ones, one question still remains unanswered: Does the mix of products that a country produces and exports predicts that country's human development and well-being?

Although studies which focus on income and income inequality are probably misleading because countries may have identical income distributions but different social welfare levels due to differences in economic and social mobility (Birdsall and Graham, 2000), the above question has remained unaddressed, first, because there is an implicit assumption that innovation-driven economic diversification has a positive effect on the freedom of choice, capabilities and well-being of people (Athur, 1994; Rosser, 2009). It is hard to imagine sustainable regional human development without innovation and product differentiation. The second reason has been the lack of economic complexity measures that use information on the industrial sophistication of economies.

It is important and valuable to study the potential causal relation between economic diversification and human development in order to generate proper public policy. If there is a connection (a causal effect of economic complexity on human development), then an improved diversity and sophistication of a country's export structure represents a set of policy options that would appear to have a significant scope to promote people's well-being.

Economic Complexity and Human Development

Expanding the relative literature's findings of a positive link between economic complexity and per-capita income (Hidalgo et al., 2007; Hidalgo and Hausmann, 2009) this note focuses on studying the likely positive or negative impact of product diversification on broader social development.

The standard argument for a positive effect of economic diversification on human development is that more economic sophistication begets a greater standard of living which, in turn, engenders more education, better health care, social services, water, electricity etc. The standard argument rests on the hypothesis that economic complexity's impact on income is direct via the increased variety of goods available, while economic complexity's impact on non-income measures is transmitted indirectly via income. Increased economic sophistication may include the production of medicines, health related equipment, and medical training, all of which improve the

well-being of the country's people. Even if economic complexity had no impact on income, we would expect the broadening of people's outlooks and their exposure to new products to foster human development: more choices mean more ideas and lifestyle possibilities, more possible functioning and capabilities and a better adaptation to individual needs (Hartmann and Pyka, 2013).

Furthermore, the idea that a country's productive structure and institutions co-evolve goes back to the writings of Adam Smith (Smith, 1776) since, for a firm to be successful in a sector, it needs to adopt the institutions that work best in that sector (Fukuyama, 1996; Hartmann et al., 2015). Different industrial structures demand different institutions (Acemoglu and Robinson, 2012). Through this process, the co-evolution of the institutional change and the creation of product diversification has a positive feedback on the country's level of education and the level of knowledge and knowhow that is embodied in its population (Hidalgo, 2015).

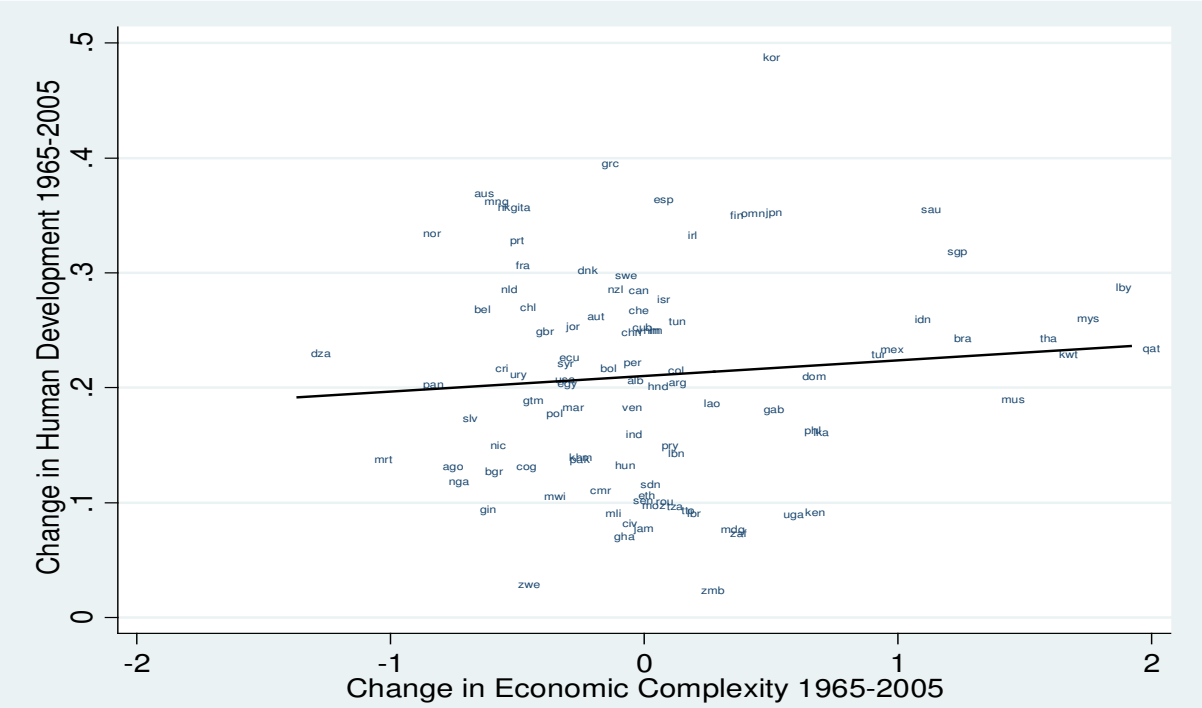
But while there are plenty of reasons why diversification has positive effects on human development (for an extended discussion see Hartmann, 2014), there are also negative effects of economic diversification on human development and well-being of people. These negative effects vary from ecological unsustainability, when the increased demand for products leads to more consumption, production and resource exploitation, to dissatisfaction and "human paralysis", due to the increased complexity and uncertainty of decision processes. "*The more choice people have, the more freedom they have, and the more freedom they have, the more welfare they have*", is not necessarily true (Schwartz, 2004).[1]

Furthermore, there might be effects that change over time and depend on the type of diversification, the economy's institutional changes and the level of the country's economic complexity. Additionally, all the above effects might be interrelated with each other. In other words, the direction of the effects might change, conditionally on the level of diversification, on various interrelation terms and on time.

In an attempt to capture the impact of economic complexity on human development and to establish causation, we model the change in the Historical Index of Human Development, developed by Prados de la Escosura (2015), as a function of the lagged value of Economic Complexity Index, available at MIT's Observatory of Economic Complexity. Our strategy is to control for country-specific factors affecting both economic diversification and human development by including country fixed effects. Though fixed effects would not help inference if there are time-varying omitted factors affecting the dependent variable and correlated with the independent variables, they are well suited to the investigation of this relationship, since a major source of potential bias in the regression is country-specific, i.e. institutional, cultural factors influencing both economic and social development. Our result is that there is no statistical effect of economic diversification on human development. Figures 1 and 2 show this diagrammatically by plotting changes in our measure of human development, for each country between 1965 and 2005, and 1970 and 1995 respectively, against the change in Economic Complexity Index (ECI) over the same period. Both Figures confirm that there is no relationship between changes in social development and changes in economic diversification.

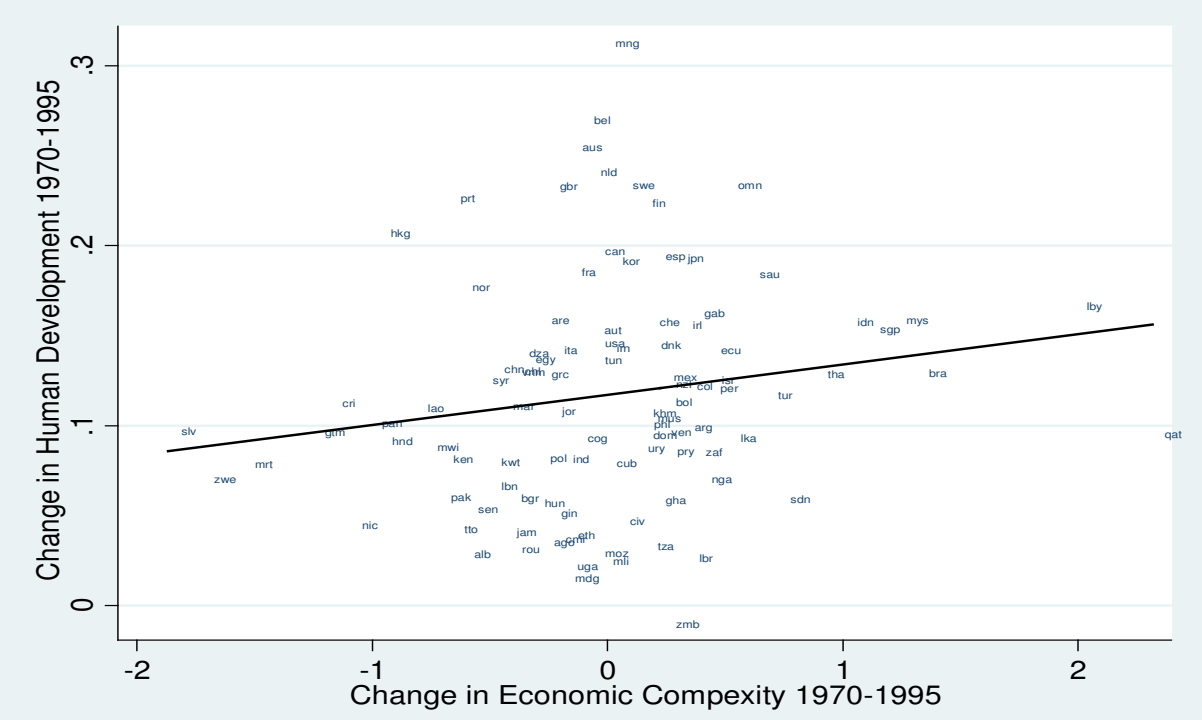
[1] The quote is from Barry Schwartz's TEDGlobal Talk in 2005 on 'The paradox of choice' (https://www.ted.com/talks/barry_schwartz_on_the_paradox_of_choice?language=en). See also Hartmann and Pyka (2013) for extensive arguments on the relationship between innovation, economic diversification and human development.

Figure 1. Change in Human Development and Economic Complexity, 1965-2005



Notes: Changes are total differences between 1965 and 2005. The regression represented by the fitted line yields a coefficient of 0.014 (standard error = 0.015), N = 100, R-squared = 0.009.

Figure 2. Change in Human Development and Economic Complexity, 1970-1995



Notes: Changes are total differences between 1970 and 1995. The regression represented by the fitted line yields a coefficient of 0.017 (standard error = 0.010), N = 101, R-squared = 0.030.

This basic finding is robust to different econometric specifications and estimation techniques. Therefore, this work sheds considerable doubt on the claim that there is a strong effect of economic diversification on human development.

2. Data

Data on Human Development

We use the historical data on Human Development Index (HDI), developed recently by Prados de la Escosura (2015). The HDI is superior to per-capita GDP for measuring social well-being since (a) it also measures various social outcome measures like life expectancy, adult literacy and gross educational enrollment; (b) it is influenced by the type of goods that constitute GDP. On the question "Can GNI per capita be used to measure human development instead of the HDI?" the UNDP claims that "Income is a means to human development, and not the end. The GNI per capita only reflects average national income. It does not reveal how that income is spent, nor whether it translates to better health, education and other human development outcomes. In fact, comparing the GNI per capita rankings and the HDI rankings of countries can reveal much about the results of national policy choices. Gabon with a GNI per capita of $16,367 (PPP$) has a GNI rank of 68, but an HDI rank 110 – the same as that of Indonesia whose GNI per capita is only $9,788 (PPP$)" (http://hdr.undp.org/en/faq-page/human-development-index-hdi). A limitation of this work -which has to do with the nature of the data on human development index- is the absence of historical data at the year level. We are aware of course that, to the extent that positive and negative effects occurring within a five year period cancel each other out, this might render no causal effect of economic diversification on HDI. However, had historical data at year level been available, we could have tried to take into account the yearly effects, something that is useful to pursue in future research.

Data on Economic Complexity

We measure the countries' productive structure using the values of the ECI available at MIT's Observatory of Economic Complexity (atlas.media.mit.edu/rankings). The ECI is calculated according to Hausmann et al. (2014)'s economic complexity formula (Technical Box 2.1) and measures the diversity and sophistication of a country's export structure, estimated from data connecting countries to the products they export. These data combine exports data from 1962 to 2000 compiled by Feenstra et al. (2005) and data extracted from the U.N. Comtrade from 2001 to 2012. The ECI captures information about an economy's level of development that is different from that captured, for example, by GDP growth or GDP per capita. To illustrate this difference, Figure 3 compares the product structures of the economies of Chile and Ecuador with those of Malaysia and Thailand respectively (Hartmann et al., 2015). Though, when using as a comparable measure the GDP per capita (source: World Development Indicators, World Bank), the economies of Chile ($18,256 at PPT in current 2011 US$) and Ecuador ($9,163) are similar to the economies of Malaysia ($20,675) and Thailand ($13,309) respectively, when their productive structures are compared the above couples of countries differ significantly. Namely, Chile and Ecuador largely export natural resources, raw materials and agricultural products while, in contrast, Malaysia and Thailand export a diverse spectrum of electronic parts, peripherals and accessories as well as

machinery, like trucks and cars. The ECI captures these differences in productive structures, assigning higher values to the more sophisticated, diversified and complex economies of Malaysia and Thailand (in 2010, Malaysia ranked 32nd while Chile ranked 68th and Thailand ranked 28th while Ecuador ranked only 95th).

Table 1 contains descriptive statistics for the two variables. The sample period is 1965-2005 and each observation corresponds to five-year intervals. The Table shows these statistics for all countries [column (1)] and also for countries with high- and low-complex productive structures, split according to median score of the ECI [columns (2) and (3)]. We report means, standard deviations, the total number of countries for which we have data and the total number of data observations. The comparison of countries with high- and low-complex productive structures confirms the pattern in Figures 4 and 5 that countries with more diversified productive structure tend to be more socially developed.

3. Econometric model and results

We estimate the following equation:

$$HDI_{it} = \alpha HDI_{it-1} + \gamma ECI_{it-1} + \mu_t + \delta_i + u_{it} \quad (1)$$

where HDI_{it} is the human development index for country i in period t. The lagged value of this variable on the right-hand side is included to capture persistence in human development. The main variable of interest is ECI_{it-1}, the lagged value of economic complexity index. The parameter γ measures the effect of economic complexity on human development. The δ_i's denote a full set of country dummies and the μ_t's denote a full set of time effects that capture common shocks to the HDI of all countries. u_{it} is the error term.

We begin by estimating a pooled OLS regression on an unbalanced panel, 1965-2005, with data at five-year intervals and country dummies for 126 countries with robust standard errors clustered by country (i.e. standard errors are fully robust against arbitrary heteroscedasticity and serial correlation at the country level; see Wooldridge, 2010). Table 2, column (1), gives the results. Lagged human development index is highly significant and indicates that there is a considerable degree of persistence in human development. The estimated coefficient of the lagged economic complexity index variable is statistically insignificant indicating the lack of causal relationship between human development and economic complexity.

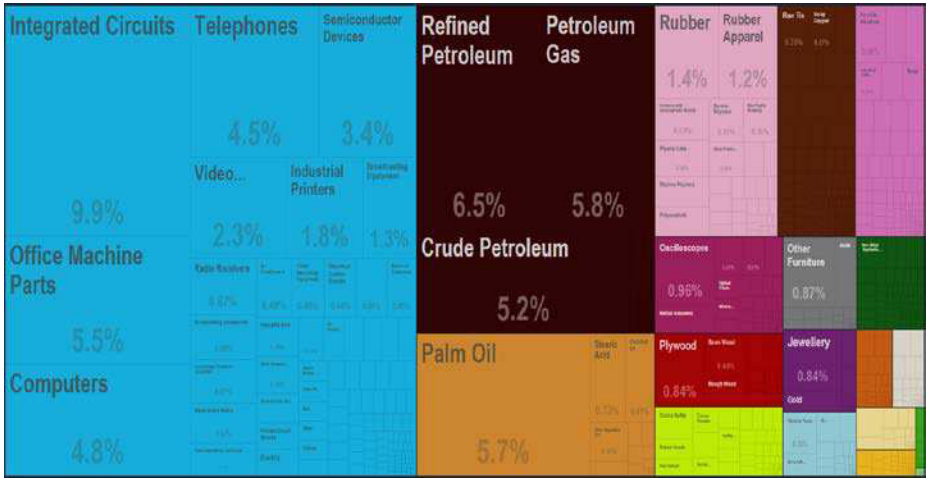
Column (2) presents our basic result with fixed effects OLS regressions with country dummies and robust standard errors clustered by country; and again illustrates the absence of a causal relationship between human development and economic complexity.

A natural concern is that the lack of causal relationship in the regressions may be driven by some unusual feature of the data. Figures 1 and 2, which plot the change in the HDI for each country between 1965 and 2005, and 1970 and 1995 respectively, against the change in ECI over the same period, yield a regression coefficient of 0.014 (with a standard error of 0.015 and R-squared = 0.009) and 0.017 (with a standard error of 0.010 and R-squared = 0.030) respectively. They show clearly that there is no strong relationship between human development and economic complexity.

Figure 3. (Colored) Export structure of Malaysia (A), Chile (B), Thailand (C) and Ecuador (D) in 2010.

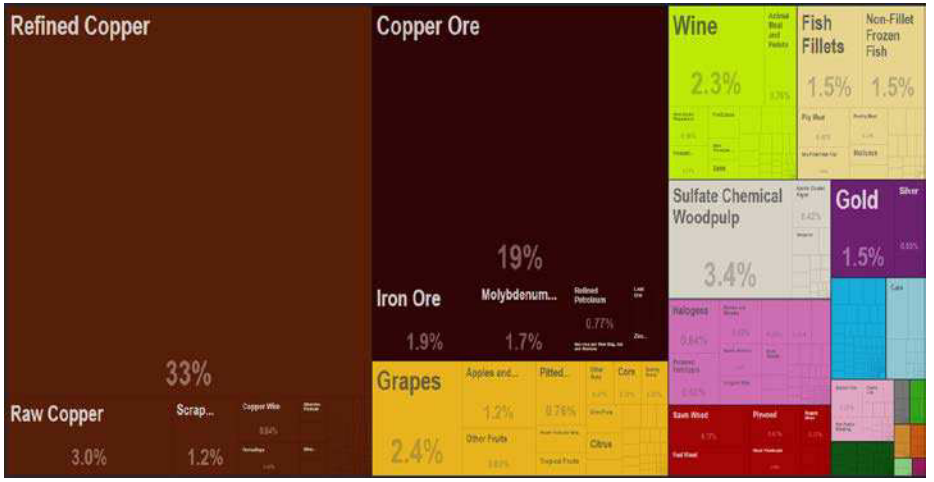
A (http://atlas.media.mit.edu/xax0hq)

Malaysia



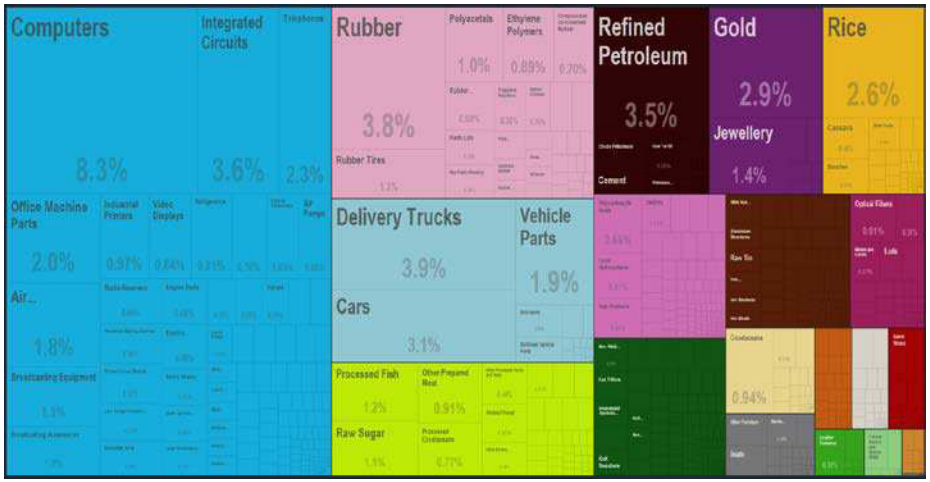
B (http://atlas.media.mit.edu/aug3u8)

Chile



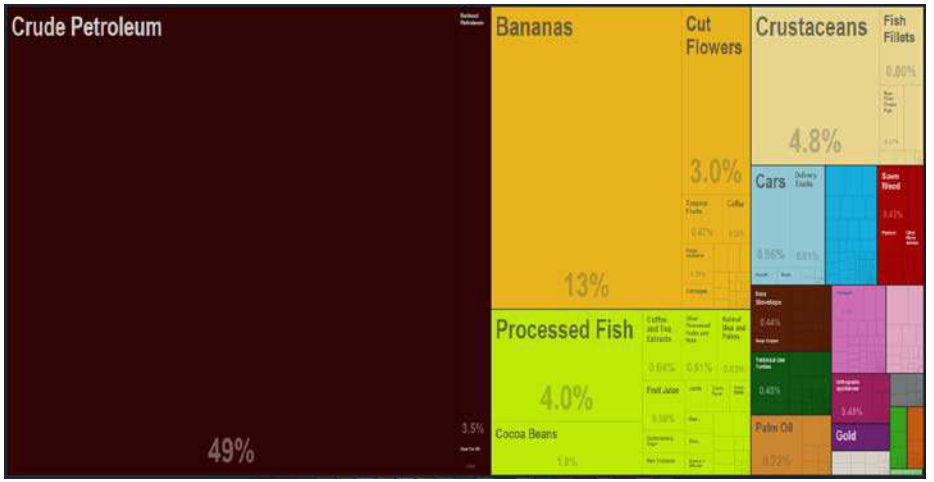
C (http://atlas.media.mit.edu/k7h1ef)

Thailand



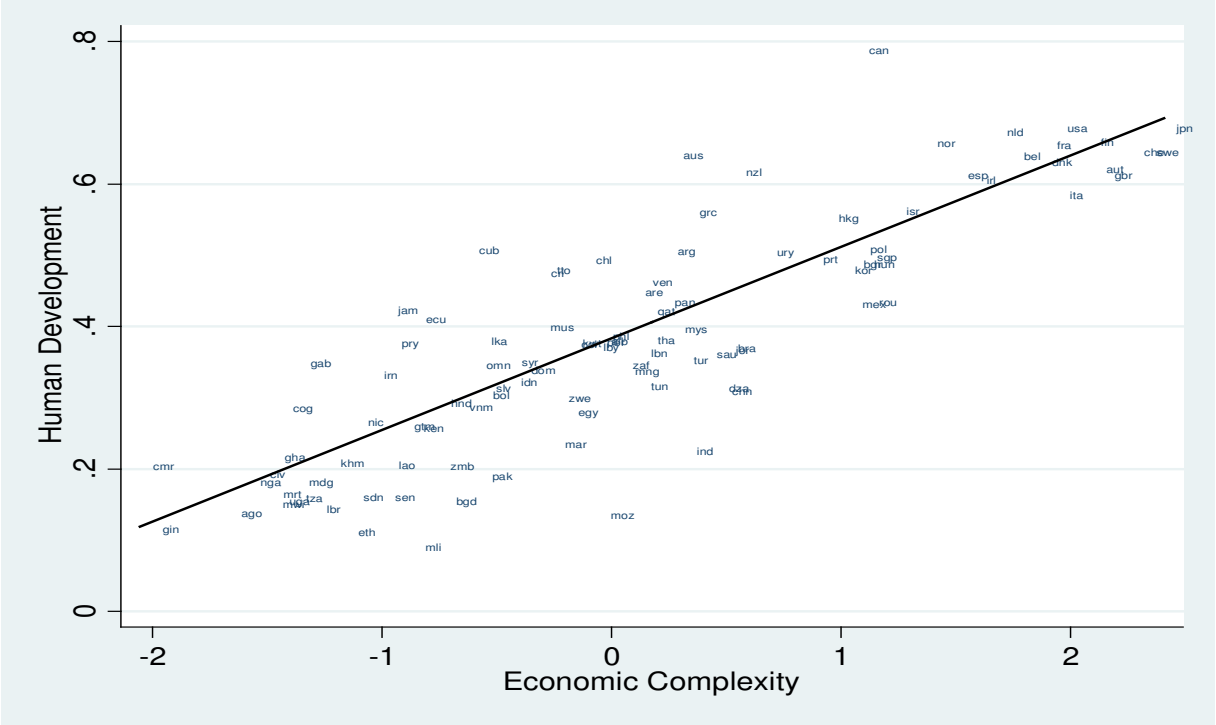
D (http://atlas.media.mit.edu/uvxxk2)

Ecuador



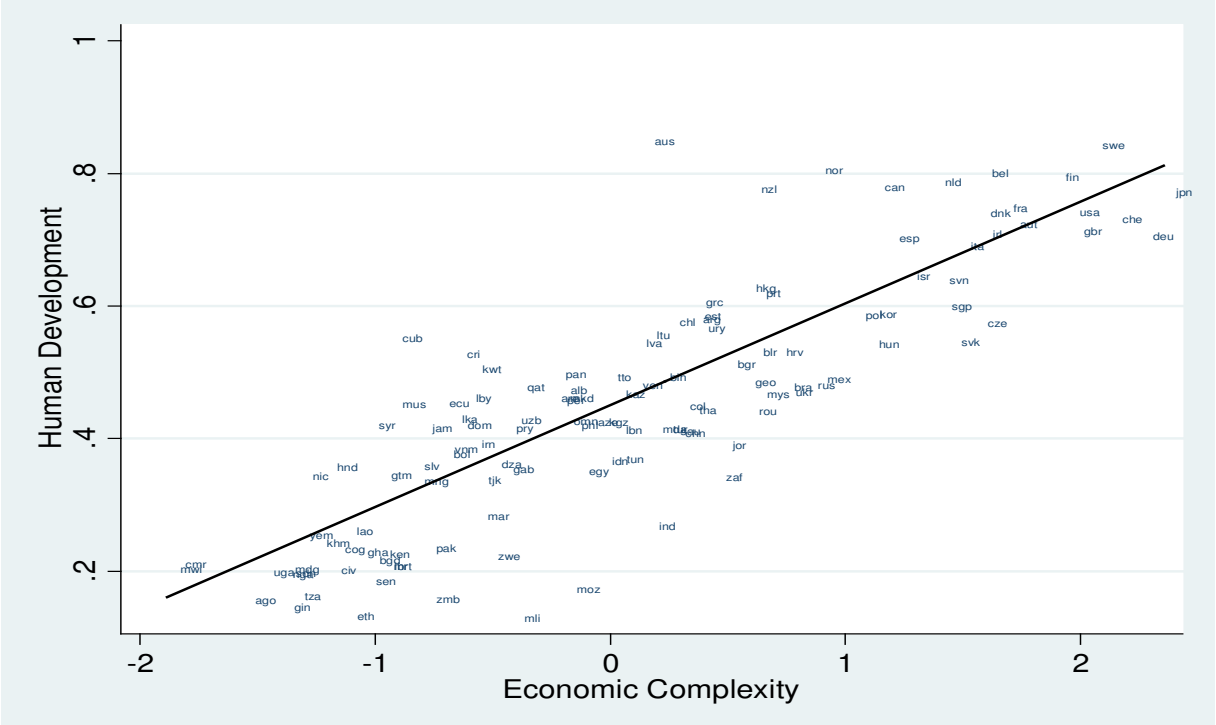
Source: MIT's Observatory of Economic Complexity (www.atlas.media.mit.edu)

Figure 4. Human Development and Economic Complexity, 1990



Notes: Values are index scores in 1990. The regression represented by the fitted line yields a coefficient of 0.13 (standard error = 0.008), N = 102, R-squared = 0.73.

Figure 5. Human Development and Economic Complexity, 2000



Notes: Values are index scores in 2000. The regression represented by the fitted line yields a coefficient of 0.15 (standard error = 0.009), N = 123, R-squared = 0.72.

Table 1. Descriptive statistics

	All countries	High-complex countries	Low-complex countries
	(1)	(2)	(3)
Human Development Index	0.39	0.50	0.27
	(0.16)	(0.12)	(0.11)
Economic Complexity Index	0.04	0.83	-0.75
	(0.98)	(0.68)	(0.45)
Observations	983	491	492
Countries	126	63	63

Notes: Values are average index scores in the sample period 1965-2005 when each index observation corresponds to five-year intervals. Standard deviations in parentheses. Column (1) refers to the full sample, and columns (2) and (3) split the sample in column (1) by the median score of the economic complexity index in the sample of column (1). The number of observations refers to the total number of observations in the unbalanced panel. The number of countries refers to the number of countries for which we have observations.

Table 2. Empirical results

	Base sample, 1965-2005 (5-year intervals data)			
	Pooled OLS	Fixed effects OLS	Anderson-Hsiao	Arrelano-Bond GMM
Dependent variable: HDI_{it}	(1)	(2)	(3)	(4)
ECI_{t-1}	0.0012	0.0003	-0.0020	0.0019
	(0.0013)	(0.0025)	(0.0053)	(0.0049)
Observations	848	848	725	725
R-squared	0.98	0.99		
Hansen J test				[0.319]
Year dummies	Yes	Yes	Yes	Yes

Notes: Pooled cross-sectional OLS regression in column (1) with robust standard errors clustered by country in parentheses (p-value of the Hansen J test in brackets). Fixed effects OLS regressions in column (2), with country dummies and robust standard errors clustered by country in parentheses. The instrumental variables method of Anderson and Hsiao (1982) in column (3), with clustered standard errors. Column (4) uses the Arellano and Bond (1991) GMM, with robust standard errors and the double-lagged economic complexity index as instrument. Year dummies are included in all estimations. Base sample is an unbalanced panel, 1965-2005, with data at five-year intervals.

The above results show that economic complexity is not a determinant of human development. Columns (3) and (4) in Table 2 consider alternative estimation strategies to deal with the potential biases introduced by the presence of the lagged dependent variable. Namely, in column (3) we use the methodology proposed by Anderson and Hsiao (1982), where time-differencing of equation (1) removes the fixed country effects:

$$\Delta HDI_{it} = \alpha \Delta HDI_{it-1} + \gamma \Delta ECI_{it-1} + \Delta \mu_t + \Delta u_{it} \quad (2)$$

Equation (2) cannot be estimated consistently by OLS, but in the absence of serial correlation in the original residual u_{it}, HDI_{it-2} is uncorrelated with Δu_{it}, hence HDI_{it-2} can be used as instrument for ΔHDI_{it-1} to obtain consistent estimates and, similarly, ECI_{it-2} can be used as an instrument for ΔECI_{it-1} . The estimation of equation (2) leads to a negative estimated γ (-0.0020 with robust standard error = 0.005) and gives no evidence of a causal effect of economic complexity on human development. The Anderson and Hsiao (1982)'s instrumental variable estimator is consistent, but as Acemoglu et al. (2008) point out, it lacks efficiency, since, under the assumption of no further serial correlation in u_{it}, HDI_{it-2} and all further lags of HDI_{it} are uncorrelated with Δu_{it} and can also be used as additional instruments.

In column (4) we use these moment conditions adopting the generalized method of moments (GMM) estimator, developed by Arellano and Bond (1991). The GMM estimator is more efficient than the Anderson and Hsiao (1982) estimator. The coefficient γ is again statistically insignificant with a magnitude of 0.0020 and robust standard error at 0.005.

Overall, the above results shed considerable doubt on the perception that economic diversification has a causal relationship with social development and people's well-being.

4. Conclusions

This note attempted to bridge a gap between theory and empirics on the causal effects of economic diversification on social welfare. Though, economic "sophistication" and exports' variety is considered in the relevant literature as a driver of economic development, we showed here, that this does not hold true for human development. We found no causal effect of economic diversification on the well-being of human agents, a result which is backed by different specifications and sensitivity analyses. We argue that, although economic diversification and social development are positively correlated (Figures 4 and 5), there is no evidence of a causal effect. This opens the discussion on why, on the one hand, economic diversification is a core driver of economic development but, on the other hand, this does not hold true for the well-being and human development. To argue on this, we need to gain a better understanding of both the relation and differentiation between economic development and people centered development and while this is a central question in the human development literature, it is beyond the scope of this note. However, from this literature's perspective, our finding might be attributed to the following: the positive effects that economic complexity has on economic agents' freedom of social choices (Sen, 1999; 2001) are possibly canceled out by negative effects (Myrdal, 1957; Schwartz, 2004), indicating that economic diversification alone does not necessarily tug human's well-being. Furthermore, economic complexity is not a 'basic human need', such as education, happiness and health (Streeten et al., 1981; Streeten, 1984; Nussbaum and Sen, 1993), hence it is not a core explanatory variable of human development.

Our analysis triggers off the need for a more comprehensive and deeper future empirical analysis of the hypothesis that economic complexity has a causal effect on human development. Even though our results do not provide evidence for a causal effect of economic diversification on social welfare, such an effect might be present but working at much lower time intervals or at different levels of economic complexity. Additionally, this causal effect might change sign over time or it might be conditional on the type of diversification and/or the institutional set-up of the economy (Myrdal, 1957; Hirschman, 1958; Nurkse, 1966; Jacobs, 1970; Schwartz, 2004; Hidalgo, 2010; Hartmann and Pyka, 2013). In other words, we do not argue that economic complexity has no effect on human development but, instead, we highlight the complex relation between the direction of economic diversification and human welfare. The exact shape of the possible relationship between economic diversification and human development evolves in dependence with the above mentioned varied effects: type of diversification, level of diversification, institutional set-up of the economy (e.g. corruption, rule of law, quality of governance etc.), time (time intervals/nature of data).

In conclusion, the potential effects of economic diversification on human development, the possible conditional relationship between them, and the impact of additional time-varying economic and social factors on the evolution of social institutions appear to be important areas for future theoretical and empirical research.

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