Title: Short-term economic impact of the Zika virus outbreak

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Since the beginning of 2016 Zika virus (ZIKV) epidemic has become a public health emergency (WHO 2016a). According to the WHO, as for August 10, 2016, the virus has been documented in over 69 countries and territory worldwide, with the largest concentration of cases in Latin American and Caribbean countries (LCR) (WHO 2016b). Though ZIKV is mainly transmitted by mosquitoes bites, in 2016, person-to-person transmission by sexual contacts (Nicastri et al. 2016a; Liuzzi et al. 2016a) has been occasionally reported in at least 11 non endemic countries including Italy, France, Spain, Portugal, Germany, United States of America, Canada, Argentina, Chile, Peru, and New Zealand (WHO 2016b).

The rapid spread of ZIKV in LCR (Petersen et al. 2016, Turrini et al 2016) and potential person-to person transmission (even though apparently very rarely documented to-date) is of great concern since the infection may be associated with a clinical conditions that may severely impact on population's health and the perception of wellbeing. These impacts are exacerbated by the associations of ZIKV infections with birth defects, mainly microcephaly (Liuzzi et al. 2016b) and post-infective neurological manifestation such as Guillain-Barre syndrome (WHO 2016a).

In addition to the public health concerns, the perception that ZIKV has a high epidemic potential could negatively affect the emergent economies of LCR and may foster overstatements on the actual risk of infections in healthy young adults, such as Olympic athletes and tourists (Attaran et al. 2016). A more judicious appraisal of the true epidemic potential is needed and this includes a careful dissection of the different types of economic impact that the ZIKV epidemic could cause (Zumla et al 2016a).

With regard to ZIKV economic implications, the World Bank estimates that the short-term impact of the ZIKV outbreak for 2016 in the LCR is about US$3.5 billion. On the other hand, the fiscal impact (i.e. the estimated amount of revenues foregone caused by a reduction on revenues or income caused by the outbreak) would be limited to US$420 million. However, the Word Bank emphasizes that economies of countries that depend significantly on tourism could drastically suffer from the ZIKV

spread, and the drop in their GDP can reach 1.6% because of decreasing tourism. As consequence, the fiscal pressures can reach up to 0.3% of GDP in several countries such as Belize, making things even more complicated for local governments since they are already facing severe shortage on fiscal space and subdued economic growth. (World Bank 2016)

In its estimate, the World Bank considers three main categories of costs.

First, the direct outlays and loss from death: which includes payments for extra doctors, nurses, drugs and prophylactic treatments. Currently, much of Zika's direct outlay has been spent trying to control mosquitoes. Furthermore, since only a relatively small number of babies have been infected so far, the World Bank does not include any estimates for death or severe impairment in its US$3.5 billion estimate.

Second, lost productivity: the World Bank assumes about four million people will be infected with ZIKV in 2016. Since roughly 20% of the infected get sick, the Bank assumes 800,000 people in LCR would lose one week of paid work.

Third, the impact of avoidance, in fact, most of the US$3.5 billion impact the World Bank estimates is related to loss of tourism in LCR countries associated with the virus outbreak. The 2016 Olympics and Paralympic Games has been held in Brazil from August 5 to 16. In 2014 the Olympic Committee forecasted that 480,000 tourists would head to Rio. However, despite this the World Bank believes that avoidance issues are the biggest factor in their estimate, they warn that if tourists exhibit widespread avoidance, its estimates will become significantly higher.

On top of these categories of costs, we propose two additional issues:

- the demographic cost due to the decision of several countries to urge women either to avoid or even to consider pregnancy termination in order to prevent their children developing birth defects caused by ZIKV (Nicastri et al. 2016b; Roa 2016);

- the impact of the Zika epidemic on stock markets due to media shocks subsequent to official alert issues.

To assess this latter issue we identified four relevant media shocks and performed two analyses using data from the Datastream database to find whether the market indices of the three major LCR countries and the major companies that are sponsoring the 2016 Olympic and Paralympic Games, report negative returns the day after each shock. We identified as shocks:

1. the WHO statement about potential causal association between Zika and severe clinical manifestations such as microcephaly and Guillain-Barre syndrome on February 1; (WHO 2016c)

2. the World Bank release of the first short-term economic costs report for ZIKV on February 18; (World Bank 2016)

3. the WHO release of the outcome of the second emergency committee on ZIKV and potential complications on March 8; (WHO 2016d)

4. the WHO release of the Situation Report for LCR on March 10. (WHO 2016e)

In the first analysis (Table panel A), we assessed the variations of the market index of three major LCR countries (namely Brazil, Argentina and Mexico). The analysis included 50 daily returns data for each market index for a total of 150 observations. The analysis shows that the market indices of these three LCR countries did not record large negative returns the day after each shock, with the exception for Brazil on February 2, 2016. The average return was -0.90% but it varied from 0.90% to -4.87% on different occasions and countries. Moreover, the mean return for each of the three indices is positive in the period considered being 0.29%, 0.25% and 0.08% for Brazil, Argentina and Mexico, respectively.

The second analysis (**Table panel B**) consists in a linear regression model adjusted for heteroskedasticity including 50 daily returns data and a total of 950 observations to assess the

association between variation of the stock returns and each media shock for 19 companies that sponsored the 2016 Olympic and Paralympic Games (i.e.: Coca Cola, Atos, Bridgestone, Dow, General Electric, McDonalds, Panasonic, P&G, Samsung, Visa, Bradesco, Correios, Claro, Nissan, Aliansce, Cisco, Estacio, Tam, and 361°). We decided to assess these companies as they are expected to be more exposed to media shocks due to their link with Olympic and Paralympic Games, and have Datastream data available in the period considered. This analysis indicates that company sponsors of the 2016 Olympic and Paralympic Games reported statistically significant negative returns after the first two shocks (on February 2 and 19). Yet, returns on March 9 and 11 are positive, statistically significant and capable to fully absorb previous losses. Furthermore, although not tabulated here, only nine companies in our sample report aggregate negative returns for the whole period of interest, whereas the other 10 companies have positive aggregate returns for the whole period.

Our results should be interpreted cautiously. A plausible interpretation is that the first two shocks released more relevant information then the subsequent ones, and therefore the stock price of the companies in our sample did not react negatively to the news released on March 9 and 11 since it had already discounted the bad news released on February 1 and 18. However, we acknowledge that those shocks could be not comprehensive and that we could potentially consider other announcements as plausible shocks. News about ZIKV have poured into mass media almost on a daily basis and it is difficult to tell with high certainty which news items carried the greatest weight and societal impact.

With this caveats in mind, the overall findings of our exploratory analysis indicate that the effect of announcements regarding the ZIKV outbreak on the stock markets has been rather marginal in magnitude. Our results indicate that bad WHO and World Bank announcements regarding the ZIKV outbreak were occasionally associated with negative returns on the next day (both for the market indexes of the three major countries affected by ZIKV, and for the companies sponsor of the 2016 Olympic and Paralympic Games). Yet, on average, the market recovered from these shocks in the subsequent period. As a matter-of-fact, these shocks did not seem to have a relevant and persistent

effect on the stock returns, and therefore do not represent a significant cost to consider in the estimation of the short-term economic consequences of the ZIKV outbreak.

The positive response and resilience of the markets represents a unique and unexpected opportunity to scale-up interventions for preventing the further spreading of the epidemic (Zumla 2016b). Previous experience with SARS and Ebola emphasize that only resilient health systems can absorb the shock of large outbreaks while maintaining regular health services for response.(Hoyt et al 2016; Ippolito et al 2015; Kieny et al. 2015). Beyond material costs, interventions for controlling Zika have a significant moral dimension as the infections target mostly impoverished women and their newborns (Rasmussen et al. 2016). In this scenario, reluctance to act robustly may have both political and economical consequence as Zika infection this summer may be followed by otherwise avoidable clusters of microcephaly in LCR and spreading of the infection across Europe and North America (Gostin et al. 2016).

Tables

Table

Panel A: Descriptive statistics of stock returns of the market indexes of three major countries affected by ZIKV after four relevant shocks

	Brazil	Argentina	Mexico
02-Feb	-4.87%	-1.57%	-1.23%
19-Feb	0.16%	-1.38%	-0.32%
09-Mar	-0.89%	-1.01%	-0.03%
11-Mar	0.14%	-0.92%	0.90%
Mean	0.29%	0.25%	0.08%
Median	0.07%	0.00%	0.11%
Min	-4.87%	-6.06%	-2.47%
Max	5.12%	5.91%	2.92%

Panel B: OLS regressions of stock returns of the companies sponsor of the 2016 Olympic and Paralympic Games on four relevant shocks

Shocks	Stock Returns	95% CI	P
02-Feb	-1.27%	(-1.34%; -1.19%)	<0.001
19-Feb	-0.39%	(-0.47%; -0.32%)	<0.001
09-Mar	0.13%	(0.05%; 0.20%)	0.002
11-Mar	1.34%	(1.25%; 1.42%)	<0.001
Control for Market Factors	Yes		
Firm-fixed effects	Yes		
Observations	950		
R-squared	81.94%		
Mean Returns for the period	0.001%		

Panel A reports descriptive statistics for the stock returns of the market indexes in Brazil, Argentina and Mexico.
Panel B reports results for the OLS regressions of stock returns of the companies sponsor of the 2016 Olympic and Paralympic Games on four relevant shocks regarding the Zika outbreak. Stock returns are calculated as (Stock Price (t) - Stock Price (t-1))/Stock Price (t-1). We include as control the residuals from a regression of companies' stock returns on market factors, i.e. the returns of three major market indexes related to the companies in our sample (see annex 1 for more details). We do this in order to study whether the shocks about ZIKV have an impact on the stock returns of the companies sponsor of the 2016 Summer Olympic and Paralympic Games above and beyond the market variations. We include firm-fixed effects in order to control for unobservable time-invariant firm characteristics. Robust standard errors are adjusted for heteroskedasticity. The unconditional mean of the returns of the companies sponsor of the 2016 Summer Olympic and Paralympic Games is reported at the bottom of Panel B.

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